COMMONWEALTH MYCOLOGICAL INSTITUTE
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THE RUBBER RESEARCH INSTITUTE OF MALAYA

ANNUAL REPORT 1940

PUBLISHED BY THE RUBBER RESEARCH INSTITUTE OF MALAYA
AND
PRINTED AT THE MALAYAN UNION GOVERNMENT PRESS,
KUALA LUMPUR.

1947.

BOARD.

At 31st December, 1940.

The Director of the Institute (Mr. H. J. Page, M.B.E.)	Chairman, *ex-officio.*
The Hon'ble the Financial Secretary, F.M.S.	Financial Member [appointed by the High Commissioner under section 5 (i) (*b*) of the Enactment] (Cap. 108).
The Hon'ble the Director of Agriculture, S.S., and Adviser on Agriculture, Malay States	*Ex-officio.*
The Hon'ble Tuan Sheikh Ahmad bin Sheikh Mustapha, J.P., M.S.C. Che Mahmud bin Mat, M.C.S.	Appointed by the High Commissioner under section 5 (i) (*d*) of the Enactment (Cap. 108).
Mr. Choo Kia Peng, C.B.E., J.P. Mr. D. Farquharson, J.P., M.S.C. Mr. W. A. Wilken, M.C., J.P. Mr. R. Heywood Mr. W. E. Wallis	Appointed by the High Commissioner under section 5 (i) (*e*) of the Enactment (Cap. 108).

Permanent Committee.

The Director of the Institute	Chairman, *ex-officio.*
The Hon'ble the Financial Secretary, F.M.S.	Financial Member, *ex-officio.*
Mr. Choo Kia Peng, C.B.E., J.P. Mr. W. A. Wilken, M.C., J.P. Mr. D. Farquharson, J.P., M.S.C.	Appointed by the High Commissioner under section 13 (i) (*c*) of the Enactment (Cap. 108).

THE

RUBBER RESEARCH INSTITUTE

OF

MALAYA

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ANNUAL REPORTS OF DIVISIONS FOR 1940.

The compilation of the Annual Report for 1940 was delayed for several reasons during 1941 and although an abridged report was prepared and issued to all on the Institute's mailing list the full reports of the work of the Divisions were not published.

When the Japanese reached Kuala Lumpur in January, 1942, these reports were still in the hands of the printers. Fortunately, the proofs were preserved in the Institute and have been kept safely although the type and the printing machines were stated to have been destroyed during the evacuation of 1942.

By the generous co-operation of the Government Printer, Mr. H. T. Ross, it has now been possible to arrange for printing and distribution of the detailed reports of the work of the several Divisions of the Institute for 1940.

Many of the records for the year 1941 have been preserved and it is proposed to issue shortly a further report covering the period January, 1941, to December, 1946.

C. E. T. MANN,
Director.

KUALA LUMPUR,
1st October, 1947.

CONTENTS.

	Page.
Report of the Board	1
Statement of Accounts	8
Report of the Director	18
Report on the Work of the Soils Division	35
——————— Botanical Division ...	38
——————— Pathological Division ...	89
——————— Chemical Division	116
——————— Experiment Station ...	133
——————— Small - Holders' Advisory Service	145
Report of the London Advisory Committee for Rubber Research (Ceylon and Malaya)	155
Appendices to Report of the Director	162

Note.—Indexes will be found at the end of the Report.

REPORT OF THE BOARD FOR THE YEAR ENDED 31ST DECEMBER, 1940.

THE BOARD—

The personnel of the Board as at the 31st December, 1940, was :

(*a*) The Director of the Institute (*Chairman*).

Mr. H. J. Page, M.B.E.

(*b*) The Financial Secretary, Federated Malay States (*Financial Member*).

The Hon'ble Mr. H. R. Joynt, M.C.S., M.F.C.

(*c*) The Director of Agriculture, Straits Settlements, and Adviser on Agriculture, Malay States.

The Hon'ble Mr. W. N. C. Belgrave, M.F.C.

(*d*) Members representing the interests of Small-holders—

The Hon'ble Tuan Sheikh Ahmad bin Sheikh Mustapha, J.P., M.F.C.

Che Mahmud bin Mat, M.C.S.

(*e*) Members nominated by Planting Associations—

Mr. W. E. Wallis.

*Mr. Choo Kia Peng, C.B.E., J.P.

Mr. R. Heywood.

*Mr. D. Farquharson, J.P., M.S.C.

*Mr. W. A. Wilken, M.C., J.P.

The Hon'ble Mr. H. R. Joynt was on leave for the period 10th January to 4th September and during his absence Mr. E. E. F. Pretty acted for him on the Board (*F.M.S. Gazette* Notification No. 280 of 18th January, 1940).

Mr. A. P. Cranna was on leave for the period 20th October, 1939, to the 22nd May, 1940, and from 14th November, 1939, Mr. J. S. Ferguson was appointed to act for Mr. A. P. Cranna on the Board (*Gazette* Notification No. 6057 of 28th November, 1939).

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* These members served on the Permanent Committee.

The term of office of five members of the Board appointed by the High Commissioner under Section 5 (i) (*d*) and (*e*) of the Rubber Research Institute of Malaya Enactment (Cap. 108) expired on the 15th June, 1940. The retiring members were—

Che Hamzah bin Abdullah, M.C.S.

Mr. Choo Kia Peng, C.B.E., J.P.

Mr. D. Farquharson, J.P., M.S.C.

Mr. A. P. Cranna.

Mr. B. J. R. Barton.

The High Commissioner by Notification No. 3684 in the *F.M.S. Government Gazette* of 4th July, 1940, appointed the following gentlemen to be members of the Board for a period of three years, with effect from the 15th June, 1940—

Che Mahmud bin Mat, M.C.S. (*vice* Che Hamzah bin Abdullah, M.C.S.)

Mr. Choo Kia Peng, C.B.E., J.P.

Mr. D. Farquharson, J.P., M.S.C.

Mr. W. E. Wallis (*vice* Mr. A. P. Cranna).

Mr. R. Heywood (*vice* Mr. B. J. R. Barton).

By Notification No. 3683 in the same *Gazette* the High Commissioner also appointed Mr. Choo Kia Peng and Mr. D. Farquharson to serve on the Permanent Committee for a period of three years, with effect from the 15th June, 1940.

MEETINGS OF THE BOARD AND COMMITTEES—

(*a*) The Board held three meetings on:

28th February.

5th July.

29th November.

(*b*) The Permanent Committee held four meetings on:

13th February.

9th May.

30th August.

22nd November.

(*c*) The Estimates (*ad hoc*) Committee held two meetings on:

8th November.

22nd November.

ACCOUNTS FOR THE YEAR 1940—

Following this report are the Income and Expenditure Account for the year 1940 and the Balance Sheet as at 31st December, 1940. The principal items are—

Total expenditure for the year	$844,312.98
,, income ,, ...	742,894.74
Excess of expenditure over income	$101,418.24

This excess of expenditure over income is chiefly accounted for by—

Depreciation 1940 (not included in Estimates) ..	$70,491.00
Adjustment of 1939 income, made by Controller of Rubber in March, 1940	25,222.00
Adjustment (partial) of 1940 income, made by Controller of Rubber in December, 1940 ..	7,500.00
	$103,213.00

Apart from depreciation, which is not included in the Estimates, the actual expenditure of the Institute was less than the original estimated expenditure by $12,578. The adjustments made by the Controller of Rubber were in respect of receipts from sales of rubber harvested on the Experiment Station and other sundry receipts including sales of budwood of R.R.I. clones.

SMALL-HOLDERS' ADVISORY SERVICE—

At the beginning of 1940 there were 33 Asiatic Rubber Instructors ; during the year six new Instructors were appointed. One resigned in October, 1940, and two were not re-engaged on the termination of their first period of six years' service with leave. At the end of the year 36 Instructors were employed in the Service.

The employment of Demonstrators to assist Asiatic Rubber Instructors in the larger districts has now become an established feature of the scheme and four more were taken on by Asiatic Rubber Instructors during the year, bringing the total to 15.

With the increase in the cadre it becomes increasingly difficult for the Small-Holders' Advisory Officer to visit each Instructor as often as is desirable. To overcome this difficulty a few of the senior Instructors have been detailed to visit and advise their juniors ; at present these men continue their own work in the districts allotted to them but it may be desirable to appoint one or two " Superintendent Instructors " to supplement the general supervision of the Instructors' work in the various districts.

The question of provision of improved planting material for small-holders was further considered during the year and arrangements were made to supply budwood of a number of first-class proprietary clones to small-holders. Budwood of these clones has been established in nurseries on the District Experiment Stations of the Department of Agriculture. Towards the end of the year arrangements were made by Government to establish multiplication nurseries up to a maximum of 200 acres to provide budwood for small-holders for use in replanting.

ACTIVITIES OF THE INSTITUTE IN 1940—

These are fully dealt with in the Reports of the Director, Heads of the various Divisions, the Experiment Station, the Small-Holders' Advisory Service and the London Advisory Committee.

It is gratifying to record that the war had not seriously hampered the Institute's activities up to the end of 1940, although compulsory military training involving most members of the staff for a continuous period of two months during the year caused some unavoidable interference.

Co-operation with other rubber research organisations has been maintained, and was strengthened by the meeting held at the Institute in February, 1940, and attended by—

Dr. A. d'Angremond	Director of the Algemeen Proefstation of A.V.R.O.S., Medan, Sumatra.
Dr. Th. G. E. Hoedt ..	Director of the Proefstation West-Java, Buitenzorg, and representative of the Central Association of Experiment Stations in the Netherlands Indies.
Dr. G. M. Kressy	Director of the Department of Rubber Research of the Proefstation West-Java, Buitenzorg (under the aegis of the International Rubber Research Board).
Mr. T. E. H. O'Brien ..	Director of the Rubber Research Scheme of Ceylon.
Mr. H. J. Page ..	Director, Rubber Research Institute of Malaya.

DISTRIBUTION OF NEW CLONES R.R.I. 300—SERIES—

A selection of ten new clones developed on the R.R.I. Experiment Station in the course of breeding and selection work by the Botanical Division was offered for sale to estates. Despatches of budwood commenced in September, 1940, and supplies had been sent to 202 estates by the end of the year. The conditions of sale are similar to those for proprietary clones, and the Board has decided to prohibit the export of these clones to countries outside Malaya for the time being.

Exchange of Planting Material with Other Countries—

Arrangements were made whereby the Institute assisted in effecting exchanges of proprietary clones between owners in Malaya and the Netherlands East Indies. The extension of exchanges to include new material developed by research organisations in the different countries was also considered at the meeting of Directors of research stations referred to above.

C. E. T. Mann,
Chairman of the Board.

A. Moore,
Acting Secretary.

Kuala Lumpur,
15th April, 1941.

ACCOUNTS.

INCOME AND EXPENDITURE ACCOUNT

Dr.

EXPENDITURE.

	$ c.	$ c.
To Experiment Station		143,938 62
,, Board and Committees (Fees and Expenses)		2,470 69
,, London Advisory Committee		22,383 84
,, London Secretarial Expenses		—
,, Salaries and Allowances		285,912 46
,, Provident Fund		29,407 96
,, Staff Leave Pay and Passages		60,233 49
,, Medical		6,551 78
,, Travelling		29,283 69
,, General Charges (Printing, Stationery, Postage, Telephones, Audit and Legal)		12,669 85
,, Staff Recruiting		155 05
,, Rents, Rates and Insurance		6,009 41
,, General Charges (Laboratories)		1,585 46
,, Maintenance Buildings (Laboratories and Residential Houses)		5,161 00
,, Maintenance Grounds (Laboratories)		2,297 77
,, Laboratories and Offices Cleaning		460 31
,, Furniture and Office Equipment: Repairs and Renewals		2,310 86
,, Fixtures and Fittings: Repairs and Renewals		2,383 51
,, Plant and Machinery (Repairs and Running)		3,703 49
,, Power, Light, Water and Sanitation		11,922 20
,, Motor Vehicles (Running)		1,989 46
,, Workshop		208 87
,, Apparatus and Glassware		6,817 46
,, Chemicals		4,153 45
,, Publications issued by the Institute		15,070 57
,, Library (New Books, Subscriptions to Periodicals and Sundries)		4,705 44
,, Exhibitions and Demonstrations		20 00
,, Small-holders' Advisory Service:		
Film Propaganda	1,484 89	
Small-holders' Advisory Officer	7,701 82	
Asiatic Rubber Instructors	68,592 12	
Experiments on Small-holdings	1,222 15	
Vernacular Publications issued	143 41	79,144 39
,, Experiments (Field and Testing Laboratory)		32,870 49
,, Depreciation for year		70,491 41
		$844,312 98

KUALA LUMPUR,
26th March, 1941.

(Sgd.) C. E. T. MANN,
Acting Director,
Chairman of the Board.

FOR THE YEAR ENDED 31st DECEMBER, 1940.

Cr.

INCOME.

	$ c.
By Contributions from Administrations	540,302 31
,, Interest on Cash and Investments	6,450 23
,, Sales of Rubber	172,808 02
,, Sales of Budwood	17,517 88
,, Sales of Publications	1,345 09
,, Rents on Buildings	1,159 14
,, Miscellaneous	3,312 07
,, Balance being Excess of Expenditure over Income for the year carried to Balance Sheet	101,418 24
	$844,312 98

(Sgd.) A. Moore,
Acting Secretary.

BALANCE SHEET AS AT

LIABILITIES.

	$ c.	$ c.
Sundry Creditors		43,666 01
Deposits for Publications		1,576 06
Reserves :		
Staff Leave Pay and Passages :		
Headquarters' Staff	49,499 33	
Experiment Station Staff	12,416 67	61,916 00
Rubber Roadways Committee		6,630 14
Excess of Assets over Liabilities :		
Balance as at 1st January, 1940	1,392,689 81	
Less Excess of Expenditure over Income for the year	101,418 24	1,291,271 57
Carried forward ..		1,405,059 78

31st DECEMBER, 1940.

ASSETS.

	$ c.	$ c.	$ c.
LAND AND BUILDINGS :			
198 Ampang Road :			
Land as at 1.1.40		10,755 00	
House as at 1.1.40	9,141 00		
Less depreciation for the year ..	1,523 49	7,617 51	
200 Ampang Road :			
As at 1.1.40	20,778 37		
Less depreciation for the year ..	3,463 02	17,315 35	35,687 86
Land behind 198 Ampang Road :			
As at 1.1.40			5,029 35
7 Eaton Rd. (formerly 5 Circular Rd.) :			
Land as at 1.1.40		17,147 08	
Building as at 1.1.40	7,119 95		
Less depreciation for the year ..	1,186 66	5,933 29	
1, 3 and 5 Eaton Road (formerly 5C, 5B, 5A Circular Road) :			
As at 1.1.40	37,604 55		
Less depreciation for the year ..	6,267 42	31,337 13	54,417 50
251 Ampang Road :			
Land as at 1.1.40		31,440 35	
Building as at 1.1.40	6,611 50		
Less depreciation for the year ..	1,101 91	5,509 59	
253, 255, 257, 259 and 261 Ampang Road :			
Buildings as at 1.1.40..	44,321 51		
Less depreciation for the year ..	7,386 91	36,934 60	73,884 54
262, 264, 266, 268 and 270 Ampang Road :			
Land as at 1.1.40		27,582 50	
Buildings as at 1.1.40..	42,082 95		
Less depreciation for the year ..	6,374 66	35,708 29	63,290 79
Land and Building on 4th Mile, Ampang Road			7,500 00
Land on Ulu Klang Road			7,705 00
Land on Ampang Road under lease ..		622 28	
Less written off		103 70	518 58
Carried forward ..			248,033 62

LIABILITIES—(*cont.*)

	$	c.
Brought forward ..	1,405,059	78
Carried forward ..	1,405,059	7

31st DECEMBER, 1940—(*cont.*)

ASSETS—(*cont.*)

	$ c.	$ c.	$ c.
Brought forward ..			248,033 62
LAND AND BUILDINGS—(*cont.*)			
Buildings and Land (Laboratories) :			
Land as at 1.1.40	19,440 00		
Add additions during the year ..	86 00	19,526 00	
Buildings as at 1.1.40	200,068 61		
Add additions during the year ..	7,267 67		
	207,336 28		
Less depreciation for the year ..	20,369 39	186,966 89	206,492 89
PLANT AND MACHINERY :			
As at 1.1.40		20,680 84	
Less written back		241 17	
		20,439 67	
Less depreciation for the year		3,065 95	17,373 72
FURNITURE :			
Residential Houses:			
As at 1.1.40	17,927 85		
Less depreciation for the year ..	1,792 78	16,135 07	
Offices :			
As at 1.1.40	7,546 40		
Less depreciation for the year ..	754 64	6,791 76	
Laboratories :			
As at 1.1.40	6,307 49		
Less depreciation for the year ..	630 75	5,676 74	
Library :			
As at 1.1.40	943 66		
Less depreciation for the year ..	94 37	849 29	29,452 86
APPARATUS AND GLASSWARE :			
As at 1.1.40		20,845 74	
Less depreciation for the year		4,169 15	16,676 59
MOTOR LORRIES :			
As at 1.1.40		2,040 00	
Less Sale of Old Lorry	180 00		
Depreciation for the year	465 00	645 00	1,395 00
Carried forward ..			519,424 68

BALANCE SHEET AS AT

LIABILITIES—(*cont.*)

	$ c.
Brought forward ..	1,405,059 78
Carried forward ..	1,405,059 78

31st DECEMBER, 1940—(*cont.*)

ASSETS—(*cont.*)

	$ c.	$ c.	$ c.
Brought forward ..			519,424 68
WORKSHOP EQUIPMENT :			
As at 1.1.40		265 30	
Less depreciation for the year		39 80	225 50
R.R.I. EXPERIMENT STATION :			
Development expenditure as at 1.1.40		500,084 95	
Add additions during the year		18,145 43	
		518,230 38	
Less depreciation for the year		11,701 81	506,528 57
LIBRARY BOOKS AND PERIODICALS : ..			
As at 1.1.40		1 00	
Add purchases during the year		2,385 97	
		2,386 97	
Less written off		2,385 97	1 00
STOCKS :			
Petrol and Oil—			
Laboratories	910 86		
Experiment Station	169 25	1,080 11	
Empty Drums and Containers :			
Laboratories	260 00		
Experiment Station	230 00	490 00	
Stationery		2,617 31	
Sundry Materials :			
Laboratories	634 24		
Experiment Station	6,616 27	7,250 51	11,437 93
SUNDRY DEPOSITS (For water, telephone, etc.) :			
Laboratories		175 00	
Experiment Station		20 00	195 00
SUNDRY DEBTORS :			
Staff :			
Institute	36,382 54		
Experiment Station	210 54	36,593 08	
Malayan Rubber Fund		40,066 16	
Accrued Interest		950 00	
Carried forward ..		77,609 24	1,037,812 68

BALANCE SHEET AS AT

LIABILITIES—(*cont.*)

	$ c.
Brought forward ..	1,405,059 78

$1,405,059 78

I hereby certify that to the best of my knowledge and belief all liabilities

KUALA LUMPUR,
26th March, 1941.

We have audited the above Balance Sheet and Income and Expenditure and certify same to be correct according to the best of our information and the

KUALA LUMPUR,
20th March, 1941.

31st DECEMBER, 1940—(*cont.*)

ASSETS—(*cont.*)

	$ c.	$ c.	$ c.
Brought forward ..		77,609 24	1,037,812 68
SUNDRY DEBTORS—(*cont.*)			
General :			
Institute	6,643 32		
Experiment Station	196 48	6,839 80	
British Rubber Producers' Research Association		4,834 40	89,283 44
SUSPENSE :			
Institute		73 23	
Hire of Power-Samas Accounting Machine under Purchase Option ..		1,139 88	
Experiment Station		57 50	1,270 61
ADVANCE PAYMENTS :			
Institute		34 51	
Experiment Station		20 00	54 51
INVESTMENTS AT COST :			
4½% Singapore Municipal Loan 1970/80 Nominal Value $15,000		17,536 69	
3½% British War Loan 1932/52 Nominal Value £17,000		145,475 43	
3% F.M.S. Government Loan 1952/59 Nominal Value $40,000		40,000 00	203,012 12
CASH AT BANK AND IN HAND :			
Chartered Bank, London		7,754 64	
Chartered Bank, Kuala Lumpur :			
Board's Account	12,934 94		
Rubber Roadways Committee ..	6,630 14		
Working Account	29,963 10		
Experiment Station	13,893 54	63,421 72	
Petty Cash :			
Secretary	123 53		
Imprest Advances	70 00		
Experiment Station	2,256 53	2,450 06	73,626 42
			$1,405,059 78

to 31st December, 1940, have been brought into account.

(Sgd.) A. MOORE,
Acting Secretary.

Account with the books and vouchers of the Rubber Research Institute of Malaya explanations given to us and as shown by the books of the Institute.

(Sgd.) GIBSON, ANDERSON, BUTLER & Co.,
Chartered Accountants,
Auditors.

*ANNUAL REPORT OF THE DIRECTOR.

The Annual Report of this Institute has grown progressively larger in recent years. Although this is partly an indication of a progressive expansion and development of the work of the Institute it was evident that the Report was becoming too big and unwieldy, and after the publication of the Report for 1939, it was obviously necessary to make some change in the method of presentation. It was intended, in any case, to make the Report for 1940 relatively short and to publish separately much of the detail hitherto included in the reports of the Divisions. Since then, as a result of paper shortage, paper control has been introduced, so that we must now make a virtue of necessity and perforce cut down the size of this report even further than originally contemplated. This is the more necessary, even beyond the strict requirements of the Paper Control Order, in order to husband our existing stocks of paper, since the shortage may become even worse. This year, therefore, all that is being issued indiscriminately to everybody on our mailing lists is an Abridged Report, consisting of the Director's Report in a shortened form, including tables of contents and summaries or extracts of the Reports of Divisions, etc. It is regretted that, as a result of delays arising from the war, this Report is late in appearing.

MEMBERS OF THE BOARD—

During the year, following the expiry of the term of office of several members of the Board, Mr. W. E. Wallis, Mr. R. Heywood and Che Mahmud bin Mat became members in place of Messrs. A. P. Cranna and J. R. Barton, and Che Hamzah bin Abdullah respectively; Mr. D. Farquharson similarly became a member of the Permanent Committee in place of Mr. A. P. Cranna.

WORK RETARDED BY MILITARY SERVICE—

The most important effect of the war on the Institute was that resulting from the compulsory embodiment, for two months, of the European staff of military age (under 41) and of Asiatic Volunteers. Altogether, fourteen members of the European staff, out of twenty-two, and five members of the Asiatic staff were absent, each for this two-month embodiment period. The effect of this was to hinder the work of the Institute by an amount appreciably greater than that corresponding to the actual amount of time absent on embodiment, and this effect was greatest in relation to the research and experimental work: owing to the simultaneous embodiment of much of the European staff on estates, the volume of requests for advice during the embodiment period was less. Apart from this interference with the work of the Institute, there were relatively few special war problems to cause diversion from the normal programme, which continued as already laid down. Difficulties in supplies of chemicals, however, seriously interfered with work on the control of soil pests.

PERMISSIBLE EXPORTS AND PRICES OF RUBBER—

Nineteen hundred and thirty-nine had already been a prosperous year for the Malayan rubber industry, and 1940 was even more so, since it combined a high rate of release by the International Rubber Regulation Committee, with high prices. The percentage of the Basic Quota which was permitted to be exported rose throughout the year, from 80 per cent. for the first two quarters to 85 per cent. for the third quarter and 90 per cent. for the fourth. The corresponding domestic releases were 80, 77½, 82½ and 90 per cent., with an average for the year of 82½ per cent. The price of No. 1 X Ribbed Smoked Sheet in Singapore varied between comparatively narrow limits, the lowest figure for the year being 35⅜ cents and the highest 39¾ cents, with an average of 37.55 cents per pound.

* The Annual Report of the Director for 1940 was issued in October, 1941, in the form of an "Abridged Report on the Work in 1940 of the Rubber Institute of Malaya by the Director" and is now re-published as the "Annual Report of the Director", with minor omissions.

Expenditure and Income—

The total expenditure (excluding depreciation, which is not provided for in the estimates) was $814,000, an increase of about $116,000 over the figure for 1939. Much of this increase was a result of increased costs arising directly from the war; much was also due to the fact that the expenditure at the Experiment Station necessarily increases steadily from year to year with the opening of new areas and the coming into tapping of others. A large part of this increased expenditure at the Experiment Station consists not of expenditure on experimental work bringing in no cash return *to the Institute*, but of revenue-producing expenditure identical in character with that incurred on an ordinary commercial estate. Such revenue-producing expenditure, under present conditions, brings in a very good return, and this is well shown by the fact that the increase in the income from the sales of rubber produced at the Experiment Station was $70,000 over that for 1939. A result of this, and of the fact that the income from the same source for 1939 proved to be $30,000 more than the estimates for that year, is that, in spite of the increased total expenditure, the 1940 contribution from the Malayan rubber producing industry, by way of the Malayan Rubber Fund, at $540,000, was over $100,000 less than in 1939.

Staff Movements and Work—

There were three losses from the Senior staff in 1940, one by the much lamented death of the Manager of the Experiment Station and two by resignation; and two gains, being new appointments to fill the vacancies caused by these resignations. Seven European officers were on long leave for varying times (excluding leave following resignation). The number of Senior staff (Research Officers, Secretary and European staff at the Experiment Station) at the end of the year was 22; the effective number of Research Officers on duty as an average figure for the year, was $16\frac{1}{2}$, disregarding absence during embodiment, or 14 when such absence is taken into account. Seven members of the Junior staff left the service of the Institute and eighteen appointments were made (including six Asiatic Rubber Instructors), three of which were from daily-paid workers already employed by the Institute. The number of Junior staff at the end of the year, including 36 Asiatic Rubber Instructors, but excluding men on daily rates of pay, was 190. The number of employees on daily rates of pay, on the 31st December, 1940, was 25 at Headquarters (including Small-Holdings) and 342 at the Experiment Station. The total number of employees of all grades at the end of the year was thus 579.

The Staff Committee met seven times during the year.

The relative amount of time spent by scientific officers, on research and experimental work, and on advisory work, remained much the same as in previous years, namely about two-thirds and one-third, though the proportion of advisory work in the Chemical Division was higher than normal as a result of special problems arising from the war. Further comment on this, beyond that made in the 1939 Report, is unnecessary.

Once more, as a result of the embodiment of the Volunteers, the projected Planters' Conference had to be postponed. The number of lectures was also less for similar reasons.

Publications—

Publications consisted of six numbers of the R. R. I. Planters' Bulletin, nine Communications of the Journal, three printed Circulars, the Annual Report for 1939, and the much-overdue new edition of Planting Manual No. 6 on the "Uses and Control of Natural Undergrowth on Rubber Estates."

During the year 72 books, excluding pamphlets and periodicals, were added to the Library.

Visitors—

The Visitors Book records 608 visitors in the year (in comparison with 861 in 1939). Together with 311 visitors to the Experiment Station, the total for the year is 919. Included in these were 32 visitors from outside Malaya. Co-operation with related departments and bodies continued as in previous years, and in many cases it was closer and more frequent than formerly as a result of problems arising out of the war, particularly in connection with supplies of chemicals and fertilizers.

Staff—

It is doubly pleasant to be able to acknowledge the steady and loyal support which I have received from all my staff, under these abnormal war conditions, though we are fortunate to have suffered in this respect so relatively little. Our sympathy goes out to our scientific colleagues in the rubber and in other industries who have not been so fortunate.

Small-Holders' Advisory Service.

At the beginning of 1940 there were 33 Asiatic Rubber Instructors; during the year six new Instructors were appointed. One resigned in October, 1940, and two were not re-engaged on the termination of their first period of six years service with leave. At the end of the year 36 Instructors were employed in the Service. The employment of Demonstrators to assist A. R. Is. in the larger districts has now become an established feature of the scheme, and four more were engaged by A. R. Is. during the year, bringing the total to fifteen. With the increase in the number of Instructors it became increasingly difficult for the Small-Holders' Advisory Officer to visit each Instructor as often as is desirable. To overcome this difficulty a few of the senior Instructors have been detailed to visit and advise their juniors; at present these men continue their own work in the districts allotted to them, but it may be desirable to appoint one or two "Superintendent Instructors" to supplement the general supervision of the Instructors' work in the various districts.

The question of provision of improved planting material for small-holders was further considered during the year, and arrangements were made to supply budwood of a number of first-class proprietary clones to small-holders. Budwood of these clones has been established in nurseries at the Agricultural Stations of the Department of Agriculture, S.S. and F.M.S. Towards the end of the year arrangements were made by Government to establish central multiplication nurseries up to a maximum of 200 acres to provide budwood for small-holders for use in replanting.

The Work of the Divisions.

The records of **advisory and administrative work** of the Division, in comparison with previous years show that in spite of the war, or rather no doubt because the industry was working at full pressure as a result of the war, there was little difference between 1939 and 1940. The figures for visits and interviews and letters received per working day per Research Officer are: 1939—3.2; 1940—3.2. As a result of absences of staff during embodiment of the Volunteers, however, a greater proportion of the advisory work had to be done by way of correspondence and interviews at the Institute, and less of it by way of visits to estates. The total number of letters received at the Institute (exclusive of routine correspondence in connection with publications and Library matters) was 10,993, an average of 37 per working day. Visits to estates (excluding the Experiment Station and small holdings) numbered 779.

On the whole, the chief subjects about which enquiries were received, and their relative numbers were not very different from those for 1939 (see Annual Report, 1939, page 30). Rather fewer enquiries regarding replanting were received by the Soils Division, but on the other hand a notable proportion of the enquiries received by the Botanical Division related to the choice of planting material for replanted areas. Abnormal conditions, arising out of the war, resulted in a considerable increase in the number of enquiries received by the Chemical Division in connection with coagulants (as a result of the scarcity of formic acid and the temporary shortage of other suitable acids), and smoke-houses (largely as a result of the marked falling-off in the latex market, so that many estates which formerly exported much or all of their output in the form of latex had to change over to the production of sheet).

As stated at the beginning of this Abridged Report, summaries of the main contents of the reports of Divisions, and of the Experiment Station, are given in the following pages.

Research and Experimental Work: General.

In the report of the work of the **Statistics Section** the Statistician records that analyses of data were carried out in connection with the results of 56 field experiments or laboratory investigations. Various sampling investigations were undertaken and much work was done on questions of experimental technique in connection with methods of recording yields from experiments, by plot and by individual trees. Sixteen visits to estates were made. Advice was given to research workers of other organisations. The Powers automatic computing installation was received and put into commission towards the end of the year. The designs of all the new experiments commenced in the field by the different Divisions, and of certain of the laboratory investigations, were prepared by or in consultation with the Statistician.

Co-operation with Cognate Research Organisations—

Co-operation by way of visits and correspondence, with sister and allied research organisations, both in the East and in Europe, continued to the fullest extent possible under prevailing conditions; the following visits were made:—

By Messrs. Mann, Piddlesden and Owen to the laboratories of the London Advisory Committee; by Mr. Moore, to Agricultural Colleges and Experiment Stations in South Africa and at Canberra, and to the Proefstation Midden und Oost Java; and by Mr. Owen to Long Ashton and Rothamsted Research Stations, Harper Adams Agricultural College and Macaulay Research Institute.

As a result of the German invasion of Holland and France, our co-operation with the research organisations in those countries necessarily ceased.

The Conference of Directors of Rubber Research Organisation in the East, to which reference was made in the 1939 Report (page 35) was held at this Institute in February, and resulted in very valuable discussions and agreement regarding the bases for future co-operation. Unfortunately, owing to the war, such co-operation with our Dutch colleagues became more difficult, but it continued actively in spite of this.

Arrangements were made whereby the Institute assisted in effecting exchanges of proprietary clones between owners in Malaya and in the Netherland East Indies. The extension of exchanges to include new material developed by research organisations in the different countries was also considered at the Conference of Directors of Research referred to above.

SOILS PROBLEMS.

Soil Survey Work—

Soil profiles on rubber estates and in jungle areas have been examined and sampled. A total of 118 profiles, involving about 10,000 analytical determinations on 669 samples, were examined during the year. Some progress was made in general mapping of soil types.

Manuring of Hevea—

Results of experiments continue to confirm those of previous years, with phosphate the predominant need for young plants, especially on replanted areas, but second to nitrogen in importance for mature areas; and with potash producing results only on the lighter soils. Experiments on the making of compost, and its use, in comparison with inorganic manures and with dung, have been started both on mature rubber trees and on new plantings. A new experiment to compare different types of phosphatic manures, and the influence of calcareous materials on them, also a new replanting manuring experiment, have been started. In the experiment on manuring in the multiplication nursery, manuring three months before or after budding did not adversely affect the buddings.

Considerable attention has been devoted to peat soils on which the growth of young rubber trees was bad. Excessive amounts of tin were found in ailing plants; this was at first thought to account for the poor growth but later work suggests that the trouble is caused by toxicity of hydrogen sulphide under the reducing, waterlogged condition of the lower layers of the peat.

Severe bending of trees about three years old has been reported from a number of areas. There is nothing to suggest that manuring is concerned in this.

The total number of manuring experiments on estates, under the control or supervision of the Soils Division, is 110.

Cover Plants and Soil Management—

Two new experiments in new clearings were started, one of which is an elaborate one, in co-operation with the scientific staff of two large groups of estates, to study the effects of different methods of clearing, and of different cover treatments, on the soil and on the growth of the rubber trees.

Results from other cover-crop experiments continue to be similar to those recorded for previous years.

The Division is supervising or controlling 15 cover-crop experiments.

Laboratory and Pot-Culture Work—

Reference is made to work on compost-making, on spectrographic analysis of young rubber plants, on leaf analysis and on the phosphate status of Malayan soils.

BOTANICAL PROBLEMS.

I.—Vegetative Propagation.

Methods of Propagation and Planting—

Further experiments on the use of growth-promoting substances with budded stumps confirmed the conclusions stated in the Report for 1939 (page 45). There were rather more failures when manuring was done in the planting hole, as compared with manuring three or six months after planting, and the growth was no better. Growth-promoting substances did not improve the rooting of cuttings of cover plants except with woody cuttings of lamtoro. Early growth of germinated Hevea seedlings appeared to be stimulated by treatment with growth-promoting substances.

Stock-Scion Influences in Buddings—

Seedling stocks from four families of clonal seedlings do not appear to possess any special merit as stocks for clone P.B. 186. Moreover, the growth of buddings of clones Tj. 1, Pilmoor B. 84 and P.B. 23 did not appear to be improved by buddings on illegitimate seedlings of the same clone. Vigour of growth of the stock, or the use of a stock of high potential yield, did not noticeably improve the growth or yield of buddings. On the other hand, there is good evidence of an effect of the scion on the stock. The vigour of growth of different clones was reflected in the growth of the stocks on which they were budded. Similarly, the yield of latex obtained from tapping the stocks below high buddings was positively related to the vigour of growth and the yielding capacity of the clones used.

Growth and Yields of Budded Trees—

Further results of the experiments detailed in the *Annual Report* for 1939 (pages 94 to 96) are recorded. In the density-of-planting experiment (*Annual Report* 1939, pages 97 to 99) the plots planted at 222 trees per acre still give the highest yield, but the even more densely planted plots with 302 and 435 trees per acre have now nearly caught them up. The inferiority in the rate of girth increase, the more densely the plots are planted, has become very marked.

II.—Tapping Investigations.

Five new tapping experiments were started and three were terminated. Further results of the tapping experiments dealt with in the *Annual Report* for 1939 are presented. Chiefly, these may be summarised thus:

Periodic ("A.B.C.") tapping shows progressively increasing benefit from the resting periods, which is greater with seedling trees than with young buddings, and greater for low-yielding than for high-yielding trees; and there are corresponding advantages in reduction of tapping cost. So far there is no significant difference between the benefits obtained with different resting periods varying from two months to six months.

On the whole, A.B.C. tapping has resulted in yields relatively little superior, on the area tapped, to those obtainable with continuous alternate-daily tapping on the whole area, so that the nett loss of crop is considerable, and much more than outweighs the advantage from saving in tapping cost.

In comparison with A.B.C. tapping, third-daily tapping on half spiral, or alternate-daily tapping on a third spiral have both given slightly better yields, with a saving in tapping cost in the first instance, but with an increase in the second.

Double-cut systems at 100% intensity show a slight advantage over the half-spiral alternate-daily system, but a much greater advantage is shown by **full spiral-fourth-daily tapping,** both on seedling and on budded trees. The latter system, however, results in a definite retardation of growth, which is greater with small than with large trees, and which is also the greater the higher the superiority in yield in comparison with the standard. However, if due precautions are taken, full-spiral tapping appears to have very pronounced practical advantages. A detailed presentation and discussion of the results of the experiments on this method of tapping has recently been published (Communication No. 254, J. Rubb. Res. Inst., Malaya), so that further discussion here is unnecessary.

The results with **daily periodic systems** (daily tapping on a half spiral for a month or other period followed by a rest for the same period) indicate only slight or no advantage in yield over the standard half-spiral alternate-daily system, with a tendency towards a somewhat lower growth rate. In one experiment, however, daily tapping for one month followed by rest for only half-a-month gave a marked increase in yield with only a slight retardation of growth.

The experiments on **slaughter-tapping** indicate that although a very great increase in yield can be obtained by using tapping systems of very high intensity over short periods, if these are continued for long the trees adapt themselves to the increased intensity, and the over-all increase in yield becomes comparatively small (*e.g.* about 20 per cent.)

A general study of the results from all the tapping experiments indicates that, regardless of the type of tapping cut employed, there is a close negative relation between yield and growth rate : systems of tapping giving the highest yield result in the greatest retardation of growth rate, and *vice versa*. This relation appears to be less marked in older trees than in young ones. Consequently, particularly with young buddings, growth records should be carefully kept, and the system of tapping used should be chosen so as to avoid serious retardation of growth.

III.—Selection and Breeding.

For the second year in succession the results of hand pollinations were very poor, the exceptionally dry weather in May and June again causing a considerable loss of fruits before they had matured. In October 23 families obtained from the 1938 hand pollinations were planted. New clones numbering 522 made from the 1938 hand pollinations were established, together with 37 new clones made from illegitimate seedlings at the Experiment Station.

Further yields from the seedlings derived from the 1928 to 1931 hand pollinations, and of the new "R.R.I. 500 series" clones derived from them, are given. The seedlings show a good increase in yield, which is particularly noticeable in certain families, notably B. 84 × G. 1, which now shows a yield of 13.5 lb. per tree at an average age of 8 years and 2 months. A selection of ten of the new R.R.I. 500 series clones were offered for sale to estates, not for general commercial planting but for planting in small permanent trial plots. Supplies had been sent to 252 estates, totalling 3,900 yards of budwood, by the end of the year. The conditions of sale are similar to those for proprietary clones and the Board has decided to prohibit for the time being the export of these clones to countries outside Malaya.

The yields of several families of illegitimate seedlings are recorded. Many of these show satisfactory increases in yield; seedlings of P.B. 49 are outstanding. Yields of seedlings from the Tjikadoe and two other Isolated Seed Gardens are recorded. Considerable variation in the yields of the different families from each garden is apparent. From the Tjikadoe Garden the highest-yielding family gave an average of over 30 lb. per tree, which is about treble the yield of the lowest yielding family. Similarly in the families from the Batu Kawan seed garden the family from clone Prang Besar 23 yielded 64 per cent. more than the lowest-yielding family derived from Prang Besar 186.

Further results in the study of the relation between early test-tapping results, and the yield actually obtained in normal tapping, are recorded. There is a still further fall in values of the correlation coefficients.

IV.—Physiological Investigations.

NUTRITION—

The study of growth and foliage characters of Hevea plants when grown in sand cultures in large pots has been continued (compare *Annual Report* 1939, page 141). Characteristic leaf symptoms for certain nutrient deficiencies have been in evidence. Certain of the plants were removed for examination and analysis. Records of the weights of leaves, shoots and roots excluding the original stumps were taken. Plants in the series where calcium was omitted from the nutrient mixture have made slightly better growth than those in the complete nutrient series. The striking effects of deficiency in phosphorus are amply demonstrated; the effect of phosphorus starvation appears to be relatively greater on the shoot system than on the root system.

STIMULATION OF BARK RENEWAL—

Experiments on the effect of applications of palm oil on young renewing bark have been continued. The marked stimulation during the first year, previously reported, has been confirmed, but in the older experiments there are indications that the lead is not maintained : after two years the total thickness of renewed bark of the untreated control trees is not much less than that of the treated trees.

TREATMENT OF SEEDS WITH GROWTH-PROMOTING SUBSTANCES—

Different proprietary preparations appear to have different effects with regard both to percentage survival and early growth, using Hevea seeds. No significant effect of growth-promoting substances on the percentage germination of cover-plant seeds was found, except that treatment at 50 C. proved effective with seed of *Centrosema pubescens* and *Pueraria javanica.*

V.—Ecological Studies.

This section gives an account of the observations on the different cover treatments on field 27 at the R.R.I. Experiment Station, which is in continuation of the results recorded in *Planting Manual* No. 6 (revised edition, page 28). Growth observations on the rubber trees on these plots show that the differences are not large. There is no significant difference between the growth of the trees on the plots planted with creeping leguminous covers and on those with controlled natural covers. On the other hand, the trees on the plots with leguminous bush covers, and with natural covers with minimum control, show the poorest growth and differ significantly from the trees under the other three treatments. The seedling trees were test-tapped in January, thinned out in March and regular tapping was commenced in July. The yields for the first half year are recorded. The trees budded in the field in April, 1935, were not large enough to bring into tapping in 1940. The yields of the sub plots planted with different types of clonal seed are also recorded.

VI.—New Field Experiments at the R.R.I. Experiment Station.

All the remaining reserve land, consisting of four sections of the area originally contained in the elephant belt, were planted. These areas will be used in 1941 for small-scale experiments.

VII.—Field Experiments on Estates.

Further experiments under the Experimental Planting provisions of the second restriction scheme were laid down. Experiments on five estates, comprising a total of 185 acres, were planted with estate seed preparatory to budding in the field for testing the later selections of R.R.I. clones. Three other estates were selected for experiments on soil problems, under the control of the Soils Division, to a total area of 150 acres.

With one exception all experiments, under the Experimental Planting scheme, which were planted with ordinary seed during the period 1936/38, have now been budded.

Weather Conditions—

The results of experiments throughout the country under this scheme must be considered closely in reference to weather conditions. The distribution of rainfall in 1940 was abnormal. The first three months were exceptionally dry, and particularly in Kedah and Kelantan serious droughts were experienced. June and July were also abnormally dry in most districts. The latter part of the year was distinguished by exceptionally heavy downpours, causing serious floods in some places. Following on the two dry years of 1938 and 1939, the abnormal conditions in 1940 had the effect of retarding growth and development in young clearings, especially those budded late in 1939. The onset of heavy rain after a prolonged drought was partly responsible for the prevalence of bark-bursts, particularly in the coastal districts.

General observations on the growth characteristics, bark, etc., of the wide range of clones and clonal seedling families under test continued to be made. Amongst the proved clones, Glenshiel I is proving to have greater vigour on some inland soil types than was expected from earlier observations, and it seems to be a very suitable clone, with regard to secondary characters, for inland estates on more fertile soils as well as on estates in the coastal districts. Clones Pilmoor D. 65 and B.D. 5., are decidedly more backward. The former appeared to suffer probably more than any other clone from the exceptionally dry weather. Tjirandji 16 and P.B. 86 both seem very susceptible to soil conditions, and it is preferable to confine their use to the more fertile soils. When buddings of Pilmoor B. 84 reach the stage of heavy branching and rapid girthing, careful attention to pruning of superfluous branches is necessary.

The trials of clonal seedlings are well established, but they are not yet old enough for comparisons to be drawn between families or between the clonal seedlings and their budded controls, but on the better soils the differences appear to be smaller than might be expected.

In the experiment comparing the value of budding in the field with planting of budded stumps and stumped buddings, all preparatory work has now been completed and very valuable results are expected in the future. In other experiments comparing budded stumps with seedlings budded in the field, measurements taken three years after planting show that the mean girth of the buddings made in the field is only the equivalent of three months growth less than that of the budded stumps planted at the same time as the seed. This is much less than the advantage for budded-stump planting which is often claimed, in spite of the fact that the conditions under which the above results were obtained are such as are generally regarded as the most favourable for budded stumps.

In the experiments where catch-crops are grown in young rubber plantations, the retardation of the growth of the rubber trees where a crop of tapioca was taken, has become less marked. Derris forms an excellent soil cover, and these experiments will give useful information regarding its tolerance of shade.

PESTS AND DISEASES.

I.—Root Diseases.

The control of root disease in connection with replanting continues to be the chief problem investigated. One new experiment was started of which details are given. The further results of the experiments already in progress are discussed in some detail, with reference to both their technical and their economic aspects. It is sufficient here to state the main practical conclusions derived from the results.

The new results obtained in 1940 have made it necessary to modify our practical recommendations in connection with replanting.

For dealing with root-disease patches in the old stand, it is now evident that it is unnecessary to dig over the open central areas of such patches. Diseased roots of *known* infected trees should be removed, but further digging is uneconomic, except to follow up further sources of infection revealed in the course of filling and holing. This may now be accepted as a general recommendation both on inland and coastal soils. It should be added that where root-disease patches are being cleaned up in mature areas which are *not* to be replanted for some considerable time, greater care must be taken over the eradication of infected roots. If the patches are to be supplied the centres need not be dug over, but annular zones at least 25 feet wide must be carefully cleaned up around the margins if reinfection of the surrounding mature trees is to be avoided. Small patches which are not to be supplied should be completely dug over.

For controlling the incidence of root disease in areas where there was no obvious evidence thereof in the old stand, poisoning by either the frill-girdling or stump-poisoning technique appears to be a cheap and successful method of clearing healthy trees, which can safely be recommended in any area where the incidence of *Fomes lignosus* after replanting is known to be low. It is especially suitable for use on steeply sloping ground, where soil disturbance must be reduced to a minimum. Care should be exercised, however, in using the method in any area where the activity of *Fomes lignosus* after replanting is likely to be high. This warning applies particularly to coastal soils. In doubtful cases normal felling is the best alternative.

The choice between poisoning by frill-girdling and stump-poisoning depends on circumstances. The latter is a little cheaper, but has the disadvantage that it must be carried out 3 months at least before felling, with consequent loss of crop.

The cheapest clearing method of all is to poison by frill-girdling and allow the poisoned trees to decay in situ. In this way felling is entirely avoided, and the old trees can be tapped right up to the time of planting, and even later if so desired. The crowns of the trees rot and fall down piecemeal and the damage caused to the young stand is surprisingly small, but the method carries a risk to human life which cannot be disregarded. The method has not been included in any of the replanting experiments described above as such experiments have to be carried out on outside estates where we cannot be expected to accept responsibility for this risk. It has been tested, however, at the Experiment Station as a method of clearing jungle trees for new planting [see *Annual Report* for 1939 (Botanical Division) page 147].

In connection with poisoning treatments, there appears to be a widespread misconception. Poisoning will *not* kill the root-disease fungus in infected roots, and it is of no value as a means of lessening their danger as sources of infection. But poisoning *does* kill healthy roots, and since the spread of root-disease fungi through the soil is brought about only by *live* roots, not dead ones, poisoning can be very effective in lessening the *spread* of root-disease.

II.—Above-ground Diseases.

Tapping Panel Diseases—

Two preparations were tested and approved for the control of Mouldy Rot, and four were rejected.

Cases of Black Stripe and Patch Canker were investigated, also sunscorch of the tapping panel which was more prevalent than usual as a result of the abnormal drought. Palm oil treatment may prove to be a good palliative.

Investigations on the possible relation of bacterial infection to brown bast were carried out.

Stem and Branch Diseases—

Pink disease occurred fairly extensively in some districts, in the wet period of the year. A proposal to use flame scorching as a method of treatment is under investigation, but cannot yet be recommended.

Spearhead dieback of buddings was also more prevalent than usual as a result of the dry weather.

Further cases of bark-bursts, to which certain clones appear to be rather prone, have been investigated, and methods of treatment are being studied.

Leaf Diseases—

Weather conditions early in the year were practically ideal for rapid wintering and refoliation, with the result that Oidium leaf mildew was practically non-existent; it was reported from only 31 estates.

The position regarding minor leaf disease was similar to that reported for 1939.

III.—Insect and Animal Pests.

Cockchafer Pest –

Work on the distribution, life history and control of the various species concerned has been actively continued. It has now been definitely established that *Psilopholis* occurs only on estates close to primary forest, and only in areas of mature rubber trees thereon. But much cockchafer-grub damage results from other species, notably species of *Leucopholis*, *Lepidiota*, *Lachnosterna* and *Exopholis*, which are essentially inhabitants of secondary forest and in some cases possibly of grass lands. The damage to rubber plantations by these species is almost wholly confined to young plants on newly cleared areas, from the grubs already in the soil before clearing. Once these have pupated, the trouble is usually over, though with certain species (*Leucopholis and Lepidiota*) the pest may sometimes persist and cause damage in mature areas, similar to that caused by *Psilopholis*.

Psilopholis is confined to a few areas; fortunately, and so far inexplicably, it shows no signs of spreading to other areas of similar soil, topography, and proximity to jungle. The harm done to the productivity of rubber areas by this species is almost wholly caused indirectly by impairment of soil conditions, through destruction of ground cover and promotion of erosion. Soil fumigation with a larvicide, which need not aim at a complete kill, but merely at a certain reduction in grub-density, is effective, but expensive. Carbon bisulphide is still the best fumigant, in spite of its secondary disadvantages, but at present it is unobtainable, even in amounts enough for experimental purposes. A satisfactory kill has been obtained with petrol, but as the effective rate of application was 172 gallons per acre, this method is not feasible under present conditions.

Since the trouble with the species other than *Psilopholis*, mentioned above, is usually only a passing one, it appears sufficient to protect the young plants in their first year, until the grubs pupate and the pest disappears from the area. This can probably be done by the use of repellants such as naphthalene and paradichlorbenzene, but experimental work has been held up owing to difficulties of obtaining supplies.

Termites ("White Ants")—

The "white ant" problem is complex and though considerable progress has been made with the treatment of attacked trees the biology and ecology of the pest are still very imperfectly understood. Until these fundamental points have been studied permanent control of the pest is not possible.

Several species are present in rubber plantations and although these are very similar to each other important difference in their habits are coming to light. Previous workers did not appreciate these distinctions so some of the information they obtained loses its value.

Control methods for white ants may be summarised as follows :

(1) Ecological, that is by attention to the surroundings. This consists of the discovery and destruction of nests and the removal of stumps and logs harbouring "white ants". It is useless to destory the easily-obtained queens of the wrong kind of termite and it also seems probable that the *Coptotermes* which attacks living trees is not the same as the *Coptotermes* usually found in dead wood. Therefore great care is necessary and as this method is very expensive further study is required before it can be recommended.

(2) Treatment of attacked trees with an insecticide. This method has been very fully dealt with in *Annual Report* 1939. Using mercury perchloride successful control can be obtained but the method has two disadvantages. First the poison does not reach the nest so there is a strong tendency for fresh trees to become infested. Secondly in cases of subterranean attack the plant is often beyond help before the attack becomes apparent.

(3) Treatment of all trees with a repellent. In order to overcome the difficulty of driving the termites from tree to tree and also to obviate the necessity for waiting until signs of damage become apparent, the application of repellent substances is being tried. An ideal repellent should be effective against the pest; harmless to the tree; durable in the soil; cheap to buy and easy to obtain. It might even be possible to combine an insecticide and repellent and it is thought that such treatment would prove very useful in new plantings both against termites and cockchafer grubs. Trials of suitable material have been held up by the difficulties of getting the necessary chemicals. Both naphthalene and paradichlorbenzene have been found promising. Experiments designed to ascertain suitable dosages, the effect on plant growth, and durability in the soil are in progress, but it has not yet been possible to test the direct insecticidal or repellent value of these chemicals against either termites or cockchafer grubs in the field.

Other Insect and Animal Pests—

Rodent damage is commonly ascribed to rats. Squirrels are often, and perhaps much more often, the culprits. It is possible, by observations on lines detailed in the Report, to decide what type of animal is actually responsible and what method to use to control it.

Besides rats and squirrels, other pests sometimes causing damage are monkeys, mouse deer, grasshoppers, "lady birds," various kinds of caterpillars, eelworms, snails and slugs. Most of these attack cover plants chiefly. Descriptions of such pests, the damage they cause, and control methods are given in the Report.

IV.—Bacteriology.

Soil Bacteriology. Nodule Bacteria—

Tubes of cultures of Rhizobium, the nodule bacteria of leguminous cover plants, were distributed to the number of 598, mostly for *Centrosema* and *Pueraria*.

Work on the isolation and testing of new strains, and the rejuvenation of old strains, was continued.

Observations from pot experiments with rubber seedlings and covers showed a marked retardation of growth of the trees by the presence of inoculated *Centrosema;* in some pots, although the *Centrosema* was prevented from climbing up the rubber plants, the growth of the latter was almost completely inhibited. It must, of course, be realised that the conditions of competition in pot cultures are very much more severe than in the field.

Latex Bacteriology—

An apparatus for collecting latex from the tree under aseptic conditions has been devised and used. Samples of latex of varying bacterial content were obtained; two samples were sterile. Observations of coagulation in relation to bacterial content were made. From the fact that the sterile samples coagulated within 24 hours and without appreciable change in acidity, it is clear that although bacterial action no doubt plays its part in natural coagulation, it is not essential thereto.

CHEMICAL AND TECHNOLOGICAL PROBLEMS.

I.—Latex.

Chemistry and Technology of Latex—

Investigations have been made on the influence of storage and other factors on the acid-value of latex. Acid formation appears to be mainly a result of the action of bacterial enzymes, which can be inactivated by heating or other means, or the production of which can be prevented by the sterilising effect of preservation with ammonia.

Further work on the "caoutchol" fraction of rubber has been carried out in association with the British Rubber Producers' Research Association. The "oxide fraction" of Bloomfield and Farmer seems closely to resemble the "caoutchol" fraction of Roberts.

Revised arrangements have been introduced for testing latex for estates.

Further work has been carried out on films for coating the inside of latex drums, to avoid discolouration.

A further number of possible latex preservatives have been tested, mostly without success. However, guaiacol may be mentioned as showing promise, and other lines are also being followed up. Bacterial counts are of importance in the study of preservation problems, and the Pathological Division has collaborated with the Chemical Division in these. The value of Santobrite (sodium pentachlorphenate) as a preservative is now well proven, used in association with small amounts of ammonia.

Urea may be used, at a strength of about 0.5 per cent., as a substitute for ammonia when used in conjunction with Santobrite.

The proposal to preserve latex by autoclaving in presence of a buffer solution has been investigated and rejected as of no practical value.

Latex Concentration—

The cutting-off of the German, Danish and Swedish markets has made difficult the purchase of centrifugal machines of proved efficiency, American-made machines being much more expensive and subject to import restrictions. A machine of English manufacture was tested. A paper was published on the centrifugal concentration of latex giving details of the performance of various machines, and reviewing the practical aspects of centrifuging on estates.

The falling-off of the latex market, however, rendered these difficulties of less practical importance for the time being, though they threatened to become onerous again as the latex market showed signs of reviving at the end of the year. Assistance was given to several estates in designing and starting centrifuge installations.

With the higher rate of export release the value of the rubber remaining in centrifuge skim—about 6 to 8 per cent—became of greater moment, and has stimulated work on improved methods of recovery. Crepe made from centrifuge skim is difficult to distinguish with certainty from some lower grades of normal crepe, though markedly different in processing properties. Work was therefore put in hand for finding simple means of identifying skim-crepe.

Concentration of latex by creaming was reviewed in a paper which will be published in the *Journal*. Further work has been carried out on the mechanism of creaming, and tests of preparations of methyl cellulose as a creaming agent were made.

II.—Technological Studies of Rubber.

The report of the Crude Rubber Committee of the American Chemical Society, with reference to standard methods of sampling and testing, and the variability of raw rubber, is discussed in relation to our experience and data.

Studies of variability have been continued. Variations in the rubber from day to day on a given estate are less than the variations from one estate to another. Rubber from young trees is more variable than that from old trees. The nature of the tapping system is an important factor in variability; there are marked differences in the physical and vulcanisation properties of sheet rubber according to the tapping system used.

The previously recorded marked difference in plasticity between the rubbers from Clones Tj. 1 and P.B. 186 has been confirmed, and has been found to occur regardless of the locality where the buddings are growing. It is, thus, an inherent characteristic difference between the clones. The study of plasticity variations in the rubber from individual trees is being continued.

III.—Modified Rubber.

The work on low water-absorption rubber has been continued and the process of manufacture adapted for use on the commercial scale. Several large samples have been sent to England and to the U.S.A. for trial by manufacturers, and reports so far received are very favourable. A suitable standard technique for determination of water-absorption by rubber has been worked out.

In development of the work on the production of softened rubber by the use of peptising agents added to the latex, applications for patents for three processes have been made, and a local planting company has started the commercial manufacture of softened rubber by one of these processes.

IV.—Estate Supplies.

The shortage of formic acid at the end of 1939 was relieved by the arrival of adequate supplies of acetic acid in 1940. The marketing of coagulants containing sulphuric acid was checked by the imposition of import control for this acid. There was a considerable increase in the number of samples of coagulants received for analysis. Various possible local sources of coagulants were investigated, such as fermented vegetable materials (*e.g.* pineapple, coconut water, toddy), tamarind extract, pyroligneous acid from charcoal kilns and coconut shells. In the absence of feasible methods of concentration, such coagulants can be used only locally, owing to high transport costs of such dilute acids.

The use of serum for coagulation (see *Annual Report*, 1939, page 210), formed the subject of a paper in the *Journal*.

The cutting-off of supplies from Scandinavia caused considerable difficulties in the supply of plywood cases. Samples of plywood from Canada, Japan, China and Australia were examined. Good locally-made plywood was found to compare favourably with the imported product.

Alternatives to paranitrophenol for mould prevention, and sodium sulphite as an anti-coagulant, have been investigated.

Supplies of aluminium and of metal gauze have been uncertain, and the Institute has been consulted by trade interests and by the control authorities.

V.—Estate Technique.

The R.R.I. Tunnel Smoke house has been widely adopted in Malaya, and has also been introduced into Burma, Ceylon and North Borneo. Modifications in design are being studied, in the light of experience on estates. A new design (type C) of larger size has been worked out.

A scrap-drying shed has been designed and is being tested.

The packing of rubber in "bare-back" bales has been the subject of considerable work. An impetus to this subject has been given by the shortage of cases. Our experiments have proved that this type of packing can be carried out cheaply on estates without the need for special equipment. Trial shipments to England and America have been made.

Sample bales wrapped in a proprietary reinforced paper have been prepared and sent to England for report.

A study is being made of estate practice in the matter of methods for avoiding the presence of sand and grit in smoked sheet, and improvements in such methods are being investigated.

THE WORK OF THE SCIENTIFIC STAFF OF THE LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA).

The Report of the Chemical Division should be read in conjunction with the Report of the above Committee. In the Technical Appendix to that report there is an account of the investigation carried out by the scientific staff to the Committee, which are summarised as follows:

As a result of the investigations on latex a comprehensive picture of its structure is being systematically developed—attention being given not only to the nature of the substances present, but also to their situation and arrangement with respect to their physical relationships. The functions of different groups of substances and the factors determining quality are in consequence becoming more clearly defined. The

information so far obtained is incomplete and the investigations are being continued, but the prospects of developing rational and practical tests for quality are definitely improved.

Preliminary work on the fractionation of rubber, ultimately connected with the possibility of obtaining different rubber hydrocarbons by selective propagation, has been in progress for some time and is leading to conclusions somewhat different from those obtained by other investigators. The results suggest that rubber contains a mixture of hydrocarbons which differ not so much in solubility as in rate of solution and that non-rubber substances can have marked effects on the rate of solution without necessarily affecting the size or chemical identity of the rubber hydrocarbon. Normal methods of testing may therefore yield misleading results concerning difference between hydrocarbon fractions and the possibility of devising a reliable test is under consideration.

In connection with the preparation on a large scale of clean and uniform rubber, attention has been given to the inconstancy of the same method of test carried out in different laboratories. It has not been found possible to eliminate all the discrepancies, but the problem is still under investigation, and there are several ways in which the difficulties may be overcome.

Manufacturers have displayed considerable interest in clean rubber and also in softened rubber prepared by a method devised by the staff of the Rubber Research Institute, Malaya, and large scale trials have been arranged.

EXPERIMENT STATION.

Acreage and Distribution of Land.

At the 31st December, 1940, the area planted was 1,228 acres, of which 812 acres were in bearing. Three-quarters of the planted area is devoted to Botanical Division experiments, and most of the remainder consists of Soils Division experiments, leaving 50 acres for the Pathological and Chemical Divisions.

Botanical Division Areas—

Particulars are given of new clearings (including costs), nurseries, and of the progress of the experiments described in previous Reports and discussed in the reports of Divisions. A total of nearly 10,000 yards of budwood and 7,000 seeds were despatched to experimental areas on various estates, as well as 3,900 yards of budwood of the new R.R.I. 500 series clones.

Soils Division Areas—

The progress of the manuring and other experiments in various fields is recorded. Experimental work was carried out on composting; a mixture of oil-palm-bunch refuse and Mikania cuttings was found to give satisfactory results. Thirty-five tons of compost were made and used in nurseries.

Pathological Division—

This Division was responsible for routine inspection and treatment throughout all fields. Altogether over 8,000 trees were treated, more than half for termites. Sulphur dusting was carried out against thrips. An experimental garden for the Entomologist was established.

Chemical Division—

Samples of sheet and latex were taken and sent to the Division, and special experiments in connection with factory technique were conducted. Bare-back baling experiments were carried out.

Routine and General.

Manuring in most mature areas is now biennial.

Fifty-five chains of new road were constructed. Further new lines for the labour force, and other buildings, were erected.

The total amount of rubber despatched for sale was 524,474 lb., and in addition nearly 18,000 lb. were sent to headquarters for experimental purposes.

The total rainfall for the year was 95.15 inches, of which 40 inches fell in the last quarter, and only 21 in the four months June/September.

The labour force totalled 342, with 158 dependants.

Nine refresher courses, for 45 estate conductors, were held.

The number of visitors, at 311, was much less than normal.

Staff.

It is with the deepest regret that the death of the Manager, Mr. T. N. Dickson, on the 7th October, 1940, is recorded.

KUALA LUMPUR,
October, 1941.

H. J. PAGE,
Director.

ANNUAL REPORT, 1940.

SOILS DIVISION.

STAFF—

The Division was below normal strength throughout the year, Mr. Owen being on leave from February to September. In addition, Dr. Dyck resigned his appointment and returned to Canada in December, his place being taken by Mr. Davidson who commenced duty at the beginning of December. Mr. Pillay went on long leave in December. Resignations by two members of the Junior Staff created vacancies for one Field Assistant and for one Laboratory Assistant. Military duty (continuous training) caused the writer to be absent for two months from July to September, and Mr. Owen during October and November. One Laboratory Assistant was also away on military duty for two months.

The report given below is in an abbreviated form, partly as an economy measure and partly because more detailed presentation of results from experiments will shortly be published separately.

Soil Survey Work.

Soil profiles on rubber estates and in jungle areas have been examined and sampled. A total of 118 profiles, involving about 10,000 determinations on 669 samples were analysed during the year. Some progress was made in general mapping of soil types.

Manuring of Hevea.

A. MATURE TREES—

Records from existing experiments have been maintained, and in general effects from nitrogen and phosphate manuring can be shown in growth and yield for inland soils, with potash only producing benefits on the more sandy soil types. Three additional experiments were commenced, two having comparisons between inorganic fertilisers and compost applications. The total number of experiments in which the Division is actively interested is thirty-three.

Difficulties in obtaining normal fertiliser supplies have extended the use of a number of fertilisers. Sulphate of ammonia has been largely substituted by nitrate of soda and groundnut cake as sources of nitrogen. Calcium cyanamide was also used to some extent, but in certain instances the results were not very satisfactory, serious leaf scorch and even defoliation being produced. These effects must be attributed to the formation of toxic nitrogenous substances from the cyanamide, which is possible under certain conditions in the field.

Phosphatic manuring is almost entirely provided by the rock phosphate locally obtained from Christmas Island, although there has been a considerable stimulus to the production of local guanos, which are, however, of very variable composition.

B. & C. Immature trees—

Detailed growth records are being obtained from all experimental areas, for both new plantings and replantings, and these confirm earlier conclusions that phosphates are the main requirement of young trees.

Two additional experiments in new clearings were started for comparing the effects of cow dung, compost and inorganic fertilisers, and also for studying various types of phosphate in combination with calcareous fertilisers.

A replanting experiment, comparing forms of nitrogenous manures, was commenced and another experiment was initiated for comparison of different levels of nitrogen, phosphorus and potassium fertilisers.

A total of 32 replanting experiments and 45 jungle-clearing manuring experiments are now under the supervision of the Soils Division.

At the Experiment Station an experiment on the effects of fertilisers applied to plants immediately before and after budgrafting was concluded and there were no indications of harmful effects where applications were made either three months prior to or three months after the budding operation.

On peat soils the poor growth of young rubber trees, in new plantings and in replantings, has been the subject of special investigation. Information obtained by spectrographic analysis of plant tissues indicated the possibility of toxicity caused by excessive quantities of minor elements, principally tin. Later investigations are showing that considerable amounts of hydrogen sulphide and ferrous compounds in the soil solution, produced by inadequate drainage conditions, are more likely to be the main toxic features affecting the young rubber plants.

The "bending" of young rubber trees aged about $2\frac{1}{2}$ to $3\frac{1}{2}$ years, of both budded and seedling origin, has been reported from a number of replanted areas and jungle clearings. Heavy wind storms are the immediate cause of the bending and it appears to occur just after branching has developed and before the main stem has had time to strengthen up to carry the heavier crown of foliage. Propping or tying the tree is normally a satisfactory procedure and recovery is achieved after a few months. Breakages are rare, but depend on the clone concerned and on the wind strength.

Cover plants and Soil management.

Two new cover-crop experiments were commenced in new clearings. In one experiment the maintenance of legume creepers is specially being examined, in conjunction with effects on the growth of the rubber of different treatments of the cover, including clean-weeding. The second experiment has been planned in co-operation with Soils Chemists employed by two large groups of estates and it is intended, initially, to study by means of soil analysis the comparative effects on the soil of burning the felled jungle with "no-burn" treatments, followed by different cover-crop treatments. Burning at different times before planting will be included.

Results from cover-crop experiments in areas of young rubber trees are as reported in previous years, and the importance of utilising covers to maintain soil moisture cannot be over-emphasized. The number of experiments dealing with cover crops which are now being supervised on estates is fifteen.

The comparative effects of covers on young rubber trees show that a slightly greater retardation is produced by creepers. An experiment in which different densities of *Albizzia moluccana* have been used as a tree cover for young rubber demonstrates very appreciable retardation of the rubber plants during the first three years, and thinning of the tree covers is now in progress in order to ascertain the benefits, if any, from more widely spaced Albizzia trees.

The establishment and maintenance of legume covers under older rubber trees is still an important problem bristling with many controversial aspects, and varying measures of success are being achieved according to the methods used and depending very largely on the local soil conditions and climatic conditions.

Laboratory and pot-culture work.

At the Experiment Station composting on an experimental basis was continued, and has included residues from oil-palm factories. Analyses of a number of completed composts have been made and where bunch-refuse has been used, satisfactory products have been obtained.

Spectrographic analyses were carried out by Dr. Dyck on rubber seedlings in connection with the nutrition of rubber plants. A series of analyses of rubber leaf samples was completed.

Investigations on the phosphate status of Malayan soils were continued, the following points being examined :

(i) uptake of phosphate by padi seedlings from soils treated with various phosphatic fertilisers ;

(ii) effect of soil particle size on the penetration of superphosphate in soils ;

(iii) phosphate fixation at different pH values ;

(iv) phosphate fixation in the presence of nitrogenous fertilisers ;

(v) relationship between free iron and aluminium and the fixation of phosphates ;

(vi) release of soil phosphates by acid treatment ;

(vii) effect of exchangeable bases on phosphate fixation in soil.

Advisory Work.

A slight decrease (7 per cent.) in the amount of correspondence was accounted for by a fall in the number of letters dealing with replanting problems.

Estate visits amounted to 183, and in addition 54 visits were made to the Experiment Station. Visitors and enquirers received at the Institute numbered 92. Lectures were given on seven occasions at outside centres.

C. G. Akhurst,
Head of the Soils Division.

Kuala Lumpur,
October, 1941.

ANNUAL REPORT.

BOTANICAL DIVISION.

STAFF AND ORGANISATION—

Mr. C. C. T. Sharp continued to act as Head of Division until the return of Mr. C. E. T. Mann from leave on 22nd March, 1940. Mr. E.R. Guest resigned his appointment and left Malaya for England in June, 1940. Dr. R. S. Russell was appointed to succeed Mr. Guest and assumed duty on 10th May, 1940, and has taken charge of the extensive programme of tapping experiments developed by Mr. Guest during 1938 and 1939.

Dr. E. D. C. Baptist was on long leave from 20th March, 1940, until 20th November, 1940.

Mr. K. N. Kaimal left on long leave on 2nd December, 1940.

It has been customary in previous years to include in the Annual Report of the Botanical Division complete summaries of the records of the various series of investigations. The report has thus consisted of a series of progress reports of a large number of experiments. In the interests of economy, in the present report detailed summaries of data have been reduced and only the principal results of the various investigations are briefly described.

I. Vegetative Propagation.

(1) METHODS OF PROPAGATION AND PLANTING—

Planting of Budded Stumps.—Experiments described in detail in the Annual Report for 1939 on the treatment of budded stumps with plant hormones (Hortomone "A" and other growth-promoting substances) combined with varying degree of root pruning and the use of fertilisers either in the planting hole or subsequent to planting have given the following principal results.

If budded stumps were severely root-pruned by the removal of all lateral roots, losses were reduced by treatment before planting with Hortomone "A" and similar growth-promoting substances. The effect was most marked with small plants less than $1\frac{1}{2}$ inches in diameter at the collar. Budded stumps which had been less severely root-pruned, varying lengths of lateral root from 3 to 12 inches being retained, showed little beneficial effect of treatment with Hortomone "A" before planting.

Although there was some indication that small stumps with lateral roots retained showed slightly better growth when treated with Hortomone "A" large, stumps over $1\frac{1}{2}$ inches in diameter showed better growth when not treated.

Root-pruning, treatment with Hortomone "A" and manuring in the planting hole at the time of planting, at three months and at six months after planting, were combined in a single experiment. The best results were obtained with large stumps on which lateral roots were retained and manuring was done three to six months after transplanting.

ERRATA.

ANNUAL REPORT, 1939.

1. Page 10i, Table XIV, under Experiment 22 *for* 320 *read* 420.
2. Page 139, Table XLI, last column opposite Family 21 *for* 29.1 *read* 23.2
3. Page 139, Table XLI, last column opposite All trees *for* 20.5 *read* 20.3.

Treatment with Hortomone " A " had no effect on large stumps but benefited small stumps slightly. Manuring in the planting hole resulted in a small increase in the percentage of failures after transplanting and the growth of the plants was not better than for those manured by superficial applications three to six months after planting.

It should be stated that all experiments were carried out on a light sandy quartzite soil. It is possible that different results would be obtained on other soils of different type.

Propagation of Cover Plants.—Experiments on treatment of cuttings of the principal species of leguminous cover plants with solutions containing growth-promoting substances such as Hortomone " A" gave negative results except with woody cuttings of lamtoro (*Leucaena glauca*).

Treatment of Hevea Seeds with Growth-substances.—Treatment of germinated seeds (primary root just emerged) with dilute solutions of plant hormones has indicated that early growth of the seedlings may be stimulated slightly by suitable treatment.

(2) Stock-scion Influences in Buddings—

Clonal seedlings as Stocks for Budding.—(*a*) Buddings of Clone P.B. 186 were made on seedling stocks of four families of clonal seedlings in December, 1932. Representative groups of seedlings of the different families and buddings made on them have been tapped for three years. The differences in yield between the different families of seedlings are small as also are the differences in yield between the groups of buddings made on them. The results to date do not indicate that seedlings of any of the families used possess special merit as stocks for budding with Clone P.B. 186.

(*b*) In another series of experiments buddings of Clones Tjirandji 1, Pilmoor B. 84 and Prang Besar 23 were made on illegitimate seedling stocks of the same clones. The buddings were made in November, 1936, and at four years from budding girth measurements showed the following interesting features. Buddings of Tjirandji 1 had made the best growth on seedlings from P.B. 23, the highest average growth of buddings of Pilmoor B. 84 was on seedlings of B. 84 ; the best growth of buddings of P.B. 23 was also on seedlings from B. 84. In all cases growth differences were small and there is little to indicate that any marked advantage has been gained, so far as growth is concerned, by budding a clone on seedlings derived from it.

At the age of four years it also appears that the inherent vigour of the stocks, as indicated by the growth of the seedlings which were not budded, has had little noticeable influence on the growth of buddings made upon them. For example, the seedlings of clone Tjirandji 1 are the most vigorous but neither Tjirandji 1 buddings nor buddings of B. 84 or P.B. 23 have made their best growth on seedlings of Tjirandji 1 parentage.

Experiments with " Twin " Plants.—The experiments with "twin" trees, i.e., pairs of trees grown from single seeds by bisection of the very young seedlings, in which one member of the twin is budded and the other remains as a seedling have given further interesting results.

The seeds used in these experiments were illegitimate seeds selected from good parent trees. Table [illegible] is a comparison of the seeds of each family were not hundred and the close agreement between the two years of representative years is illustrated by the following figures. The trees were eight to ten years old in 1940.

Origin of Seedlings	No. of Pairs	Average Diameter	Average Height	Average Diameter	Average Height
Pilmore A. 44	36	38.3	37.3	31.3	38.9
Pilmore B. 38					
Young Stock 24	32	36.3	34.1	33.1	36.9

These figures demonstrate that the two members of a pair may be almost identical in vigour of growth and vield.

In the first experiment the remainder of each pair was burned at a height of 12 inches above the ground. The remainder remained unburned. Clones Pilmore A, B.D. 3, Young Stock 100 and Pilmore D. 30 were used as stocks. It has already been shown that during the first two years of spring there is no close relationship between the yield of the budding and the yield of the unburned member of the pair. The highest yielding seedlings were not those made on the highest yielding stocks.

During the month beginning June, 1941, the spring buds were cut, inches from ground level in January so that the budded trees were burned to the stock below the level of the union. The [illegible] results are summarized in Table 2 below.

TABLE 2.—Data from Series 2. Girth and Yield of Pairs of Trees of which one member is budded.

Clones used as stocks	No. of Pairs	Average Girth at height of 12 inches.		Average Yield per Annum.	
		Unburned Member.	Burned Member.	Unburned Member.	Burned Member.
P.M. 100	24	29.4	31.5	33.5	36.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B.D. 3	21	31.2	31.3	34.7	35.4
Pil. B. 30	3	33.5	34.1	32.3	36.3
All Clones	52	30.2	32.1	34.7	[illegible]

Budding has generally reduced the size of the tree ; this is particularly noticeable in the group budded with Clone B.D. 5, the least vigorous of the clones used, but stocks budded with clone Tjirandji 1, the most vigorous clone, have made slightly larger trees than the corresponding members of the pairs which were not budded. Bearing in mind that for all trees tapping was on seedling bark (on the stock below the union in the budded a-member of each twin) it will be noted that stocks budded with Tjirandji 1 gave yields more than double those from corresponding seedlings which had not been budded. Yields of stocks below B.D. 5 scions are approximately half as large as those from corresponding seedlings which were not budded. Between these extremes clones P.B. 186 and D. 65 occupy intermediate positions.

A third series of twin plants including larger numbers of pairs of which the a-members were budded with clones P.B. 186, Pilmoor B. 84 and Avros 50 was tapped during the year. The results for the first tapping year confirm the principal observations made on the older trees of the first series described above.

Influence of Scion on Yield of Stock in "High-budded" trees.—The experiment on high-budding of seedlings and tapping on the stock below the union has been continued. During the third tapping year it has become increasingly evident that the scion may have a positive effect on the yield of the stock. On trees budded at a high level (up to a maximum height of 48 inches from the ground in this experiment) yields have been found to decrease gradually with the increase in the distance of the tapping cut below the point of union of the scion and the stock. If the scion had no influence on the yield of the stock then yields would be expected to increase as the tapping cut on the stock approached the base of the tree as in normal seedling trees. In this experiment, taking the mean of the results with four clones (Avros 50 and 152, S.R. 9 and P.B. 186) the highest yields have been obtained in the third year from trees which were tapped on the stock from the level of the union to ten inches below it. In general, the lowest yields from high-budded trees were obtained at the base of the tree where they were approximately equal to those of the control seedling trees tapped at the same level.

(3) Growth and Yields of Budded Trees—

Comparative Trials of Clones at the Experiment Station.—The yields from seven clone trial experiments on the Experiment Station are given in Table II. In Fields 5 and 21 the tapping cuts approached the union during the first half of the year and new cuts were opened in July. This has had a depressing effect on the yields of all clones, particularly Avros 50 and P.B. 186 in Field 5, and only small increases in yield can be recorded from these two fields.

In Field 17A the tapping cuts of the budded trees were low down on the tapping panel throughout the year and there has been a decline in the yields of nearly all clones, this being most marked in Tjirandji 1 and 16.

TABLE II.—*Summary of Yield Records of Budded Trees on the R.R.I. Experiment Station, Sungei Buloh.*

(Yields of trees tapped S/2, d/2, 100% only).

Field No.	Area in acres.	Description of field.	Clone.	Tappable trees (percentage).					No. of trees recorded (1940).	Yield in lb. per tree per year (160 tappings).					Wind Damage (percentage) to end of 1940.	Brown Bast (percentage) 1940.
				1936.	1937.	1938.	1939.	1940.		1936.	1937	1938.	1939.	1940.		
5	40	Planted in November, 1929, with budded stumps in monoolone plots of 121 points (11 rows x 11). Original stand: 108 trees per acre. Randomised block clone trial with 4 replications; plot centres (9 rows x 9) split for 3 tapping treatments in 1938. Age at commencement of tapping (Jan. 1936): 6 years.	Avros 49	66	84	88	91	95	86	4.6	6.5	8.9	9.8	10.4	—	—
			Avros 50	64	97	97	98	99	86	4.5	7.0	8.8	10.4	9.9	—	0.1
			Avros 152	59	80	84	89	90	96	3.7	4.8	5.9	6.5	7.5	1.2	0.1
			B.D. 5	18	75	93	95	99	85	4.1	5.3	6.6	7.3	8.4	0.5	0.1
			Pil. A. 44	75	94	97	99	100	80	8.1	9.0	9.5	9.8	10.4	8.3	—
			Pil. B. 84	86	98	98	98	100	90	5.8	8.5	9.2	10.2	11.4	0.6	2.2
			P.B. 23	57	83	90	91	94	80	4.9	7.7	8.8	10.1	11.1	—	1.3
			P.B. 186	74	88	99	99	99	89	4.9	8.1	9.5	11.2	10.6	1.5	0.2
			Tj. 1	76	89	94	94	96	91	7.4	10.2	12.2	13.9	14.0	2.3	0.2
10	10	Planted in February, 1929. Budded at different heights (from collar to 48") from October, 1931 to December, 1932. Records from trees budded at normal height only. Age at commencement of tapping (Jan. 1938): $6\frac{1}{4}$ years.	Avros 50		—	66	83	89	26	—	—	4.5	7.3	10.1	3.0	—
			Avros 152		—	63	77	86	25	—	—	6.1	6.6	9.7	—	—
			P.B. 186		—	70	73	86	24	—	—	5.4	7.3	9.4	6.0	3.0
			S.R. 9		—	30	40	48	14	—	—	4.3	6.3	10.0	—	—

TABLE II.—*Summary of Yield Records of Budded Trees on the R.R.I. Experiment Station, Sungei Buloh—(cont.).*

(Yields of trees tapped S/2, d/2, 100% only)—(cont.).

Field No.	Area in acres.	Description of field.	Clone.	Tappable trees (percentage).					No. of trees recorded (1940).	Yield in lb. per tree per year (160 tappings).					Wind Damage (percentage) to end of 1940.	Brown Bast (percentage) 1940.
				1936.	1937.	1938.	1939.	1940.		1936.	1937	1938	1939	1940.		
17A	10	Planted October, 1929. Clones budded in succession Dec., 1930. Interplanted April, 1930, with unselected seedlings. Original stand 180 trees per acre in equal proportions of budgrafts and seedlings; stand reduced in 1937 to 125 trees per acre (86 buddings and 39 seedlings). Age at commencement of tapping (Jan., 1936): Budgrafts 5 years; Seedlings $5\frac{3}{4}$ years.	Avros 50	10	34	50	67	75	103	3.1	3.8	5.3	6.2	6.5	—	0.2
			Avros 183	9	29	37	51	59	85	6.4	7.7	9.1	9.7	8.7	1.4	—
			Avros 185	18	48	65	73	76	106	8.0	8.1	8.8	8.7	7.7	3.6	—
			Glen. 1	26	44	57	68	71	104	6.4	7.6	9.2	10.0	9.2	—	4.8
			Tj. 1	51	63	68	82	87	115	6.7	9.3	12.7	16.7	14.9	8.1	0.1
			Tj. 16	16	39	52	62	73	100	6.4	7.4	8.3	9.3	7.7	—	—
			Seedlings	79	100	100	100	100	384	3 2	4.9	5.4	6.6	7.7	1.8	0.9
17C	4.8	Planted October, 1929. Interplanted with stumps November, 1930. Budded October, 1931. Stand 180 trees per acre in equal proportions of Av. 50 and D. 65. Reduced to 120 trees per acre in 1940. Age at commencement of tapping (Jan., 1938) $6\frac{1}{4}$ years.	Avros 50	—	—	48	68	76	265	—	-	3.5	4.9	6.0	0.6	—
			Pil. D. 65	—	—	56	64	77	242	—	-	3.7	6.5	9.0	0.3	0.3

TABLE II.—*Summary of Yield Records of Budded Trees on the R.R.I. Experiment Station, Sungei Buloh—(cont.).*

(Yields of trees tapped S/2, d/2, 100% only)—(cont.).

Field No.	Area in acres.	Description of field.	Clone.	Tappable trees (percentage).					No. of trees recorded (1940).	Yield in lb. per tree per year (160 tappings).					Wind Damage (percentage) to end of 1940.	Brown Bast (percentage) 1940.
				1936.	1937.	1938.	1939.	1940.		1936.	1937.	1938.	1939.	1940.		
17D South	10	Planted October, 1929. Clones budded in succession April, 1931. Interplanted April, 1930, with unselected seedlings. Original stand 180 trees per acre in equal proportions of budgrafts and seedlings ; stand reduced in July, 1938, to 125 trees per acre (75 buddings and 50 seedlings). Age at commencement of tapping (Jan., 1937) Budgrafts $5\frac{3}{4}$ years ; Seedlings of $6\frac{3}{4}$ years.	Avros 50	—	23	41	53	63	80	—	3.7	3.8	5.6	7.2	—	—
			Glen. 1	—	21	30	45	58	73	—	6.1	6.7	7.5	9.9	1.5	—
			Rub. 393	—	24	37	50	56	66	—	2.9	3.4	5.4	8.3	—	—
			Sab. 24	—	22	36	50	59	69	—	4.0	4.8	7.7	9.4	—	—
			Tj. 1	—	45	50	64	70	89	—	7.2	7.1	9.5	14.4	2.0	0.6
			Tj. 16	—	17	28	36	43	52	—	6.5	6.3	8.2	10.2	0.7	—
			Seedlings		70	84	91	92	419	—	3.6	4.4	6.7	6.0	0.7	0.2
21	25	Planted in December, 1929. Clones budded in succession October, 1931. Original stand 90 trees per acre. Randomised block tapping experiment with 6 replications of 4 treatments set up in 1938. Age of commencement of tapping (Jan., 1936) : $4\frac{1}{4}$ years.	Avros 50	22	53	69	75	81	49	2.9	4.8	7.2	9.6	10.1	1.5	0.7
			Avros 71	47	59	67	72	78	46	3.6	6.1	8.4	9.7	11.7	9.5	0.4
			Avros 256	21	43	57	68	70	45	2.3	3.0	3.8	5.6	5.9	0.3	—
			B.D. 10	40	55	72	77	80	47	3.5	6.5	7.8	10.3	11.4	6.2	—
			Ct. 88	40	59	70	79	82	50	4.5	6.5	8.5	10.3	12.0	3.3	2.2
			S.R. 9	9	25	42	59	62	33	2.9	4.8	5.8	6.8	7.7	0.9	0.7
			Tj. 16	10	35	43	58	63	37	6.3	8.3	9.4	10.5	11.1	3.6	0.4

TABLE II.—*Summary of Yield Records of Budded Trees on the R.R.I. Experiment Station, Sungei Buloh—(cont.).*

(Yields of trees tapped S/2, d/2, 100% only)—(cont.).

Field No.	Area in acres.	Description of field.	Clone.	Tappable trees (percentage).					No. of trees recorded (1940).	Yield in lb. per tree per year (160 tappings).					Wind Damage (percentage) to end of 1940.	Brown Bast (percentage) 1940.
				1936.	1937.	1938	1939.	1940.		1936	1937	1938.	1939.	1940		
22A North	10	Planted in December, 1930. Budded in December, 1932 (polyclone budding in regular succession). Original stand 90 trees per acre. Age at commencement of tapping (Jan., 1938) : 5 years.	Avros 49	-	-	35	—	—	60	-	—	5.0	5.7	—	-	-
			Avros 152	-	-	32	—	—	56		—	4.2	4.6			
			P.B. 186	-	—	33	—	—	52			4.3	6.3		2.4	0.8
			Rub. 393	—	—	42	—	—	65			4.0	6.9		1.7	0.5
			Tj. 1	—	—	47	—	—	70		-	7.5	11.6		9.7	—

In Field 17C clone D. 65, after a slow start is now yielding fifty per cent. more than the control clone Avros 50.

Further details of these experiments were given in the Annual Report, 1939 (p. 94 to 96) and will not be repeated here.

Influence of the Density of Planting on the growth and yield of Budded Trees.

In the density-of-planting experiment (see Annual Report, 1939, pp. 97-99) the C-plots planted at 222 trees per acre still give the highest yield, but the yields of the D-and E-plots, containing 302 and 435 trees per acre, have been catching up steadily and are now only a little behind (Table III). There is a steady increase in yield per tree and the yields of the trees in the A-plots exceed those in the E-plots by 225 per cent.

The girth increments of the different treatments decline steadily as the density of planting increases, being only half-an-inch in the densest plots. Even then it is possible that the full effect of increased density does not appear in the measurements given in the table. Tapping itself probably causes a reduction in the rate of growth at all densities and since the proportion of untapped trees increases with increasing density of planting the reduction in the rate of growth due to tapping would be expected to be least in the densest plantings.

II. Tapping Investigations.

During 1940 five new tapping experiments were designed while three experiments were terminated. No important alterations in the tapping procedure of the remaining investigations were made but additional work on growth and bark renewal was undertaken in several experiments. The methods of recording and analysing detailed records were reorganized following the installation of Powers-Samas computing equipment in the Statistician's laboratory. The accuracy and efficiency with which the increasing volume of yield and other returns are dealt with has been much improved thereby.

The majority of the experiments of which results are given in this report were laid down in the years 1938 and 1939. Although results for many further years must be awaited before final conclusions are reached, several of the investigations are already at a stage when they merit more detailed discussion than is practicable in the Annual Report. The full results will therefore be presented, from time to time, in separate papers in the *Journal* of the Institute.* To obviate unnecessary duplication only the most important features of results which are being presented *in extenso* elsewhere will be referred to in this Report.

It has been found desirable to present the results in a different sequence from that followed in previous years. The reference numbers of the experiments are, however, unchanged. The new arrangement facilitates the comparison of the effects of each tapping treatment in the different experiments. Hence results of general application can be distinguished from effects due to the special conditions of one locality.

The international tapping notation is followed throughout (Guest, J. R. R. I. M., 10, Coms. 246 and 247, 1940).

* In this connection the following papers have been published or will be issued shortly :

Experiments with Economic Tapping Systems (3), Tapping-cum-Manuring Experiments—Part 1. (Guest, *J. Rubb. Res. Inst. Malaya*, Com. 253, 1940).

Full-Spiral Tapping: (Russell, *J. Rubb. Res. Inst. Malaya*, Com. 254, 1941).

TABLE III.—*Density-of-Planting Experiment (Field 14C and D, R.R.I. Experiment Station).*

Planted: December, 1930, with budded stumps of Clone Avros 50.

Plot Index	Planting Distance in feet.	No. of trees per acre.	GIRTH MEASUREMENTS. Mean Girth in inches at the end of each year of life.									YIELD DATA FOR 1937, 1938, 1939, 1940. Percentage of trees tapped.				Yield in lb. per tree.				Yield in lb. per acre.			
			2	3	4	5	6	7	8	9	10	1937	1938	1939	1940	1937	1938	1939	1940	1937	1938	1939	1940
A	30 × 30	48	4.8	8.0	12.1	16.4	19.3	21.5	25.5	28.0	30.1	75	91	93	95	5.7	7.5	10.1	13.3	261.3	324.0	496.8	625.8
B	20 × 20	109	5.1	8.3	12.1	16.3	18.7	19.1	21.0	22.2	23.2	64	74	79	81	5.7	5.8	6.7	7.9	345.8	458.1	647.1	720.7
F	20 △	125	5.1	8.2	12.1	15.5	18.1	18.8	20.8	22.0	23.3	61	76	83	84	5.0	5.7	6.4	7.6	344.9	511.2	655.1	818.5
C	14 × 14	222	4.9	7.8	11.5	14.8	17.1	17.3	18.8	19.4	20.3	51	65	72	76	4.2	4.0	4.9	5.5	421.2	563.9	816.1	948.0
D	12 × 12	302	5.1	8.2	11.7	14.2	15.9	15.6	17.0	17.5	18.2	39	53	62	64	3.7	3.6	4.0	4.7	384.7	539.2	800.2	927.0
E	10 × 10	435	5.2	8.1	11.1	13.2	14.7	14.1	15.4	15.9	16.4	20	34	48	52	3.9	3.5	3.4	4.1	262.6	463.6	742.0	917.8

Note.—GIRTH MEASUREMENTS. Up to the 6th year, all trees in each plot were measured . . . . Each plot = 1.1 acres.

After the 6th year, boundary belts are excluded from the records. . Each plot = 0.65 acres.

There are six plots planted at each density.

1. Comparison of Tapping Systems on Seedling Trees.

"A.B.C." Tapping on Mature Seedlings—Tapping Experiments Nos. 21 to 26—

The object of these experiments is to study the effect of various alternate-daily periodic ("A.B.C.") systems on the yield of mature seedling rubber. The following tapping systems are employed :

(1) C/2, d/2, 100% (Control) (3) C/2, d/2, 8m/12, 67%

(2) C/2, d/2, 4m/6, 67% (4) C/2, d/2, 12m/18, 67%

Comparative tapping for two years was completed in October, 1940 and a full description of the experiments will be published shortly. Statistical analysis has shown that Experiment 21 was situated on an area so irregular in yield that accurate comparison of treatment effects was impossible. This experiment was consequently terminated. The data of the remaining five experiments are summarised in Table IV.

Table IV.—*Tapping Experiments 21-26, Yield of No. 1 Rubber and Tapping Costs.*

Tapping Systems: Control, C/2, d/2, 100%; Periodic system, C/2, d/2, 4m/6, 67%, C/2, d/2, 8m/12, 67% and C/2, d/2, 12m/18, 67%.

Experiment Number & Locality.	First Year (Nov., 1938-Oct., 1939).			Second Year (Nov., 1939-Oct., 1940).		
	Yield of Control: lb./acre.	Mean Relative Yield *all* periodic systems (1).	Relative Tapping Cost (2).	Yield of Control: lb./acre.	Mean Relative Yield *all* periodic systems.	Relative Tapping Cost.
22 Batu Tiga	352.7	69.3	96.7	405.4	90.4	74.1
23 Batu Tiga	390.1	56.7	118.2	407.2	75.6	88.6
24 Batu Tiga	318.7	72.3	92.7	329.0	103.9	64.5
25 Kota Tinggi	321.1	75.0	89.3	352.9	93.2	71.9
26 Kota Tinggi	297.2	79.1	84.7	328.8	102.8	65.2

Note (1) **Relative Yield** is calculated from over-all yields. Hence if no increase in yield per tapping resulted in the periodic systems the relative yield would be 67 per cent.

Note (2) **Relative tapping cost** is calculated by expressing the tapping cost per lb. dry rubber in the periodic tapping systems as a percentage of the cost for the control.

Note (3) The Yields for the first year are for No. 1 rubber only and differ from those published in the A.R. 1939 which include scrap.

The most important results may be summarised as follows.

(i) During the second year a highly significant benefit from rest has appeared in the A.B.C. treatments in all experiments and tapping costs have been further reduced.

(ii) The benefit from rest is greatest in the low yielding areas and least in the high yielding areas.

(iii) No significant difference between the periodic systems has yet appeared. For this reason the *mean* values for the three systems are shown in Table IV.

Full-spiral, double-cut (two half-spirals) and single half-spiral tapping on Seedling Trees, Tapping Experiment No. 47, R. R. I. E. S., Field 6—

The design of this experiment was modified early in 1940 on the advice of the Statistician as it was found that two sections of the control group of trees were boundary rows favourably situated in relation to all other groups. Since the control was duplicated in the original design this modification could be readily made. The relative yields from the commencement of the experiment have been re-calculated in relation to the single control group and are summarised below.

Tapping System.	Yield August, 1935, to December, 1939.	Yield January, 1940, to December, 1940.
1. Control S/2, d/2, 100%	100	100
2. Double-cut periodic .. 2S/2, d/2, 3m/6, 100%	105	104
3. Double-cut fourth-daily .. 2S/2, d/4, 100%	118	107
4. Full-spiral fourth-daily .. S/1, d/4, 100%	141	136

Note :—In the double-cut systems two half-spiral cuts are tapped one on each side of the tree one cut being 20 inches higher than the other.

The excellent performance of the trees on the full-spiral fourth-daily system has been well maintained.

2. Comparison of Tapping Systems on Budded Trees.

The principal experiments in progress on the tapping of budded trees fall into two main groups—"large-scale" and "single-task" experiments. The function of these two types of investigations is different.

In the large-scale experiments (Section A, p. 50) the conditions of tapping approximate more or less closely to normal estate practice. In several of the experiments each plot is a normal commercial task. Thus these investigations may be expected to yield results which are reproducible under estate conditions. The large area required for experiments of this type makes it impossible for many tapping systems to be compared in one experiment.

On the other hand the "single-task" experiments (Section B, p. 55), which were first described on pp. 116-121 of the Annual Report for 1939, make possible the comparison of a large number of tapping systems in a small area. The results depend on the recording of the yield of each tree separately, the individual trees being regarded as "plots". Statistical analysis has shown that accurate comparisons are obtainable by this method but it is considered that the results should be confirmed in large-scale experiments, under conditions which are comparable with those in estate practice, before they are applied widely in commercial areas. Thus the policy has been adopted of studying new tapping methods first in experiments with a large number of replications of single-tree plots and subsequently undertaking large-scale investigations with those systems which show most promise. This procedure eliminates the danger of large areas being placed, at considerable expense and risk of damage to the trees, on tapping systems which may prove to be of little value.

In addition to the above main classes of experiments there is a group of small-scale investigations, varying in type, which have been undertaken on small areas particularly convenient for experimental work. These experiments likewise are a useful guide in designing future large-scale investigations.

Section A. Large-Scale Experiments—

In Table V details of the various experiments are set out. In all the experiments, except Nos. 41 and 42, normal tapping tasks constitute the experimental plots. The principal results of these investigations are grouped together by tapping systems in Table VI.

TABLE V.—*Comparison of Different Tapping Systems on Budded Trees.*
List of Large-Scale Tapping Experiments.

Tapping experiment No.	Locality.	Clones.	Tapping systems compared with S/2,d/2,100%; Control.	Mean age of trees in January, 1940.	Date of commencement of experiment.	Approximate acreage of experimental area.
1	Negri Sembilan	P.B. 25		12 yrs.	Oct., 1934	54.8
2	Johore	Avros 49	S/2,d/2,6m/9,67%	12 ,,	Jan., 1936	56.7
3	,,	Avros 50	S/2,d/3,67%	11 ,,	Jan., 1936	59.2
4	,,	Avros 152		12 ,,	Jan., 1936	54.6
5	Negri Sembilan	S.R. 9		12 ,,	Oct., 1936	62.1
6	Johore	B.D. 5	S/2,d/2,6m/9,67% S/2,d/1,m/2,100%	$9\frac{1}{2}$,,	Oct., 1939	48.9
7	,,	Tj. 1	S/2,d/2 (2x7m/14), 100% S/1,d/4,100%	$8\frac{1}{4}$,,	Oct., 1939	52.0
33	Prang Besar Estate	Mixed P.B. Clones & S.R. 9	S/3,d/2,67% S/2,d/3,67% S/1,d/4,100% S/2,d/1,m/2,100%	8 ,,	Jan., 1939	71.3
41	R.R.I.E.S. Field 5	Avros 49 Avros 50 Avros 152 B.D. 5 Pil. A. 44 Pil. B. 84 P.B. 23 P.B. 186 Tj. 1	S/2,d/1,m/2,100% S/2,d/2,6m/9,67%	10 ,,	Jan., 1938	40.0
42	R.R.I.E.S. Field 21	Avros 50 Avros 71 Avros 256 B.D. 10 Ct. 88 S.R. 9 Tj. 16	S/1,d/4,100% S/2,d/1,m/2,100% S/2,d/1,P/2,100%	$8\frac{1}{2}$,,	Jan., 1938	25.0

In all experiments alternate-daily tapping on a half-circumference cut (S/2, d/2, 100%) is employed as the control system and is used as the basis for comparison of other systems. Records of yield, girth increment and tapping cost under other tapping systems are expressed as percentages of the corresponding values for the control. These percentage comparisons, termed **Relative yield, Relative girth increment** and **Relative tapping cost,** facilitate the assessment of the effects of the various modifications in tapping systems. So that the general yield level of the various experimental areas can be judged, the yield of the control system in pounds per acre per annum is also shown.

The main results shown in Table VI will be considered briefly.

Alternate-daily periodic tapping.—S/2, d/2, 6m/9, 67%. This system is employed in eight experiments in which eleven clones are represented. In almost all cases yield is in excess of 67 per cent., indicating that yield per tapping has been increased as a result of rest. This is particularly marked for the clones Prang Besar 23, Pilmoor A. 44 and B. 84 and Avros 152 in Experiment No. 41. On the other hand, in Experiment No. 4, Avros 152 shows no benefit from rest. This may be associated with the fact that Avros 152 in Experiment 4 is on a better soil and gives higher yields on the control system than in Experiment 41.

There is a marked tendency for the relative yield for 1940 to be higher than in previous years in experiments which have been in progress for a lengthy period. This indicates that benefit of rest develops progressively. Comparing Table VI with Table IV, it will be seen that periodic rest has a much smaller effect on young budded trees than on mature seedlings. This is no doubt due to the higher yield capacity of the vigorous young budded trees. Although tapping cost is somewhat reduced the loss of crop is considerable in the majority of the budded areas. Growth has been improved by the reduction in tapping intensity the effect being particularly marked for clone Avros 49 in Experiment 41.

Other systems at reduced intensity.—(i) S/2, d/3, 67%. Continuous third-daily tapping on half-circumference cuts has given slightly higher yields than the S/2, d/2, 6m/9 system. A saving in tapping cost is again obtained at the expense of a considerable loss of crop.

(ii) S/3, d/2, 67%. Continuous alternate-daily tapping on one-third circumference has resulted in yield and growth at the same level as in the S/2, d/3, 67% system. On account of the larger number of tappings tapping costs are very high when third-circumference cuts are employed.

Daily Periodic Tapping.—(i) S/2, d/1, m/2, 100%. This system has led to a small increase in yield in the majority of clones though the effect is in many cases not statistically significant. There has been a general slight reduction in tapping costs. In experiments for which records for more than one year are available, relative yield has increased for all clones except Avros 50 and Avros 256 (Experiment No. 42). Clone B.D. 5 shows a slight reduction in yield in Experiment No. 6 which has been in progress for only one year. A similar effect was found from this clone in the first and second years of Experiment No. 41 but in the third year the yield has risen to approximately the same level as in the control.

In the majority of clones growth has been poorer than in the control. It may be noted, however, that for Experiment No. 42 the average growth rate is not significantly different from that of the control for 1940. In earlier years, however, the growth rate was significantly less.

(ii) S/2, d/1, P/2, 100% : "*Economic Periods*".—In Experiment No. 42 two series of trees were tapped on the S/2, d/1, m/2, 100% system for the first two years of the experiment. At the beginning of the third year "economic" periods of tapping and rest were introduced (see *Annual Report*, 1939, p. 112). The curves for daily yield and the progressive mean yield were studied and it was assumed that the highest yield would be obtained if the trees were rested as soon as the daily yield fell below the mean yield for the period. On this assumption the "economic" period for clone Ct. 88 was 24 days.

TABLE VI.—*Comparison of Different Tapping Systems on Budded Trees—Large-scale Experiments.*

Summary of Results by Tapping Systems, 1940.

(*a*) Alternate-daily periodic tapping (A.B.C.), S/2, d/2, 6m/9, 67%.

Expt. No.	Clone.	Results, 1940.				Previous results.	
		Yield lb/ac/an. of rubber all grades of control (S/2,d/2,100%).	Relative yield.	Relative girth increment.	Relative tapping cost.	No. of years experimental tapping previous to 1940.	Mean relative yield.
2	Avros 49	928	81	..	83	4	76
41	,, ,,	838	81	152	83	2	71
3	,, 50	932	69	..	97	4	69
41	,, ,,	855	83	120	81	2	63
4	,, 152	1,126	67	..	99	4	67
41	,, ,,	684	89	106	75	2	80
41	P.B. 23	886	97	120	69	2	84
1	,, 25	1,209	78	..	86	5	68
41	,, 186	940	71	107	94	2	62
41	Pil. A. 44	818	90	101	74	2	74
41	Pil. B. 84	982	91	119	73	2	78
7	Tj. 1	964	73	126	92	nil	..
41	,,	1,277	83	112	80	2	68
6	B.D. 5	689	64	106	105	nil	..
41	,, ,,	724	78	124	86	2	71
5	S.R. 9	753	76	..	88	3	72

(*b*) Other Systems at reduced intensity.

(i) *S/2, d/3*, 67%. *Tapping on half-circumference every third day.*

1	P.B. 25	1,209	76	..	88	5	68
2	Avros 49	928	84	..	80	4	70
3	,, 50	932	73	..	92	4	65
4	,, 152	1,126	73	..	92	4	67
5	S.R. 9	753	89	..	75	3	71
33	Mixed P.B. Clones and S.R. 9	1,066	80	107	84	1	78

(ii) *S/3, d/2*, 67% *Tapping on one-third circumference alternate-daily.*

33	Mixed P.B. Clones and S.R. 9	1,066	81	107	123	1	74

TABLE VI—(*cont.*)

(*c*) Daily Periodic Tapping.

(i) *S*/2, *d*/1, *m*/2, 100%. *Daily tapping on half-circumference in alternate months.*

Expt. No.	Clone.	Results, 1940. Yield lb/ac/an. of rubber all grades of control (S/2, d/2, 100%).	Relative yield.	Relative girth increment.	Relative tapping cost.	Previous results. No. of years experimental tapping previous to 1940.	Mean relative yield.
41	Avros 49	838	115	76	87	2	103
41	,, 50	855	103	94	97	2	95
42	,, 50	584	105	97	94	2	111
42	,, 71	674	110	99	91	2	99
41	,, 152	684	140	81	71	2	124
42	,, 256	346	113	99	88	2	128
41	P.B. 23	886	109	112	92	2	107
41	,, 186	940	94	107	106	2	80
41	Pil. A. 44	818	107	78	93	2	105
41	,, B. 84	982	108	95	93	2	97
7	Tj. 1	964	112	104	89	nil	..
41	,, 1	1,277	117	101	85	2	96
42	,, 16	641	105	94	95	2	106
6	B.D. 5	689	87	88	114	nil	..
41	,,	724	102	113	98	2	88
42	B.D. 10	657	136	150	74	2	114
42	S.R. 9	454	106	121	93	2	98
42	Ct. 88	690	120	86	83	2	119
33	Mixed P.B. Clones and S.R. 9	1,066	103	95	97	1	93

(ii) *S*/2, *d*/1, *p*/2, 100%. *Daily tapping in alternate periods.*

42	Avros 50	584	110	105	91	..	..
	,, 71	674	102	103	98	..	..
	,, 256	346	133	89	75	..	..
	B.D. 10	657	122	107	82	..	..
	Ct. 88	690	124	97	80	..	..
	S.R. 9	454	88	119	114	..	..
	Tj. 16	641	100	92	99	..	..

(*d*) Full-Spiral Fourth-daily Tapping (S/1, d/4, 100%.)

6	B.D. 5	689	132	63	50	nil	..
7	Tj. 1	964	129	67	55	nil	..
33	Mixed P.B. Clones and S.R. 9	1,066	106	80	67	1	113
42	Avros 50	584	122	89	61	2	139
	,, 71	674	139	85	54	2	132
	,, 256	346	149	71	50	2	91
	B.D. 10	657	147	57	51	2	135
	Ct. 88	690	153	61	49	2	190
	S.R. 9	454	111	101	68	2	102
	Tj. 16	641	108	69	69	2	111

For clone Avros 256 on the other hand, the yield was still rising at the end of the month and the economic period was assumed, by extrapolation, to be in the neighbourhood of 48 days. For the remaining clones the period was taken as 36 days. The results for the first year on this modified system show that the only clone for which the yield has been significantly increased is Avros 256. Clone S.R. 9 gives a considerable drop in relative yield as a result of the extension of the periods, and the yield for B.D. 10 has also decreased. For the remaining clones yield is similar to that obtained in daily alternate-monthly tapping. These results suggest that the form of the yield curves are affected by the alteration of the periods of rest to an extent which makes them of much less value in the determination of the economic optima than was previously assumed. The rate of girth increment has not been significantly affected by the alteration of the tapping periods.

Full-Spiral Fourth-Daily Tapping (*S*/1, d/4, 100%). Full-spiral fourth-daily tapping has in every case resulted in increased yields, markedly reduced tapping costs and retarded growth. The clones which show the largest increments in yield tend to show the greatest retardation of growth (*e.g.*, Ct. 88 and B.D. 10). It should be borne in mind that all the trees tapped in these experiments are young (see Table V) and until data for older and larger trees are available the full value of this treatment cannot be assessed. Full-spiral tapping systems are considered to be of great promise provided that certain precautions are observed in applying them and a detailed review of the results so far obtained has been published (*J. Rubb. Res. Inst. Malaya, Com.* 254).

Section B. Small-scale, "Single-task" Experiments—

Details of the locality and history of single-task experiments are given below :

Tapping Expt. No.	Locality.	Clone.	Date of commencement of experiment.	Age of Trees at commencement of experiment.	Mean girth of Trees at commencement of experiment.
8	Bahau District	Tj.1	Nov., 1939	8 years	22.3 inches
34	Belata River Estate	B.D.5	May, 1939	$7\frac{1}{2}$,,	20.5 ,,
46	R.R.I.E.S. Field 19A	B.D.5	Oct., 1939	$8\frac{1}{2}$,,	21.1 ,,

The results of the first year of Experiments Nos. 8 and 46 and for the first eighteen months of Experiment No. 34 are summarised in Table VII. The significant differences for treatment comparisons are given at the bottom of the table. As in Section A, the principal results of these "single-task" experiments are briefly discussed.

Tapping at reduced intensity : (*Systems 2 to 5 in Table VII*).—Resting the trees for two months during wintering, System (2), has led to a reduction in yield which is significantly less than the reduction in tapping intensity. Growth has not been significantly affected.

The three systems (Nos. 3, 4 and 5) at 67 per cent. intensity all show a big reduction in yield. The only cases where the reduction in yield is significantly less than the reduction in tapping intensity are Tapping System (3) for Experiment No. 46 and Tapping System (4) for Experiment No. 34. The reduction in yield is most marked in Tapping System (5) and the girth data show that growth has benefited most from the treatment. Thus the reduction of tapping intensity to 67 per cent. has resulted in a considerable loss of crop and only a slight saving in tapping cost ; similar results were obtained in the " large-scale " experiments (see Section A above).

Daily Periodic Tapping : (*Systems 6 and 7 in Table VII*).—Daily alternate-monthly tapping has resulted in increased yields especially in clone Tj. 1 Growth has been retarded. In Experiment No. 46 the increase of tapping intensity to 133 per cent. [Tapping System (7)] has led to a large increase in yield but only a slight reduction in growth rate has resulted.

TABLE VII.—*Results of "Single-Task" Tapping Experiments.*

YIELD OF DRY RUBBER:—*Yield of Control (S/2, d/2, 100%) expressed as pounds dry rubber per tree.*
Yield of other Tapping Systems expressed as **relative yield** *(percentage of control).*

GIRTH INCREMENT:—*Girth increment above the tapping panel in control system expressed in centimetres.*
Girth increment above the tapping panel in other tapping systems expressed as **relative girth increment**

Index No.	Tapping Systems. System.	No. of Experiment	Yield of Dry Rubber. 8	34		46	Girth Increment. 8	34		46
		Clone:	Tj. 1	B.D. 5		B.D. 5	Tj. 1	B.D. 5		B.D. 5
		Year of Expt.:	First	First	Second (6 mths.)	First	First (15 mths.)	First (14 mths.)	Second (6 mths.)	First (12 mths.)
	Control System:									
1	(1) S/2,d/2,100%		8.5 lb.	4.5 lb.	(3.4 lb.)	7.4 lb.	5.3 cm.	4.7 cm.	(4.2 cm.)	7.3 cm.
	Tapping at Reduced Intensity:									
2	S/2,d/2,10m/12,83% (rest during wintering)		93	87	99	96	94	89	108	110
3	S/2,d/2,6m/9,67%		76	69	71	79	113	102	96	124
4	S/2,d/3,67%		70	81	87	76	107	102	95	113
5	S/3,d/2,67%		73	68	69	76	115	114	113	123
	Daily Periodic Tapping:									
6	S/2,d/1,m/2,100%		121	106	115	118	79	87	79	90
7	S/2,d/1,m/1.5,133%		..	..	..	144	..	..	..	87
	Full-Spiral Tapping:									
8	S/1,d/3,133%		173	157	167	155	50	55	58	67
9	S/1,d/3,3m/4,100%		134	122	142	119	61	72	63	74
10	S/1,d/4,100%		149	146	165	135	43	55	59	63
11	S/1,d/4,10m/12,83% (rest during wintering)		126	127	176	126	45	55	60	68

TABLE VII.—*Results of "Single-Task" Tapping Experiments—(cont.).*

Index No.	Tapping Systems. System.		Yield of Dry Rubber.				Girth Increment.			
		No. of Experiment	8	34		46	8	34		46
		Clone :	Tj. 1	B.D. 5		B.D. 5	Tj. 1	B.D. 5		B.D. 5
		Year of Expt. :	First	First	Second (6 mths.)	First	First (15 mths.)	First (14 mths.)	Second (6 mths.)	First (12 mths.)
	Change-over and Double-Cut Systems:									
12	S/2,d/2,(2x2d/4),100%		160	..	..	108	70	..	..	90
13	S/2,d/2,(2x7m/14),100%		105	97	113	..	100	98	88	..
14	2S/4,d/2,100%		114	..	..	116	89	..	..	93
15	2S/4,d/1,m/1.5,133%		150	..	..	..	76	..	..	..
	Significant Difference:									
	(P=.05)		9.7	10.2	..	11.6	14.0	13.7	11.3	15.9

As it was necessary to make the initial girth measurements before the experiments were laid out the time covered by these records does not coincide exactly with the experimental years. The interval of time (in months) between the measurements is therefore shown.

Full-Spiral Tapping : (Systems 8 to 11 in Table VII)—

The full-spiral tapping systems all show considerable increases in yield correlated with very marked reduction in growth rate. The results for the first half of the second year of Experiment No. 34 indicate however that the retardation of growth has not yet affected yield. It may be noted that the retardation of growth found in these experiments appears to be associated with the small size of the trees. There is evidence also that the reduction of tapping intensity by periodic rest ameliorates this undesirable characteristic of full-spiral tapping without affecting the great economy in tapping cost which has been shown in the large-scale experiments.

Change-over and Double-cut systems : (Systems 12 to 15 in Table VII)—

In tapping system (12) half-spiral cuts on opposite sides of the tree, one cut being 20 inches higher than the other, are tapped on alternate tapping days. Clone Tj. 1 has shown a very considerable increase in yield on this system while the rate of growth is much reduced. No significant effect of system (13) in which tapping panels are changed-over every seven months was apparent in the first year of tapping, but in the second year of Experiment 34 a significant increase in yield has resulted from the change-over system. Growth rate has been somewhat depressed.

Two quarter-cuts are tapped alternate-daily in system (14). The results for Experiments 8 and 46 show that the substitution of two quarter-cuts for one half-cut leads to a significant increase in yield. This is indicated also by system (15) in which two quarter-cuts are tapped on a daily periodic system at 133 per cent intensity.

Correlation between Yield and Growth rate—

It is apparent from Table VII that there is a close negative correlation between yield and growth. The rate of girth increment is highest under tapping systems giving the lowest yields and least under the systems which give highest yields. This effect is not specific to any type of tapping cut although, as noted above, it is greatest on the full-spiral system when this system is applied on small trees.

There is reason to believe that the negative correlation between yield and growth is less noticeable in older trees which would normally be growing less rapidly. The practical importance of the present results is however clear : increase in tapping intensity during the first few years may retard the growth of young buddings very considerably. Growth should be carefully observed and unless future crop is to be prejudiced the intensity of tapping should be adjusted so that a satisfactory growth rate in maintained.

3. Tapping-Cum-Manuring Experiments.

The principal experiments included here are :

Experiment 31, Sepang Estate, Mixed P.B. Clones.
„ 32, Sogomana Estate, Clone B.D. 5.
„ 36, Kalumpang Estate, Seedlings.

The design of these experiments with the results for the first tapping year were published during 1940 (Guest : Experiments with Economic Tapping Systems (3) ; *J. Rubb. Res. Inst. Malaya* Communication 253, 1940).

The yield and growth data for the first two years are summarised in Table VIII. No significant results of manuring on either yield or growth have yet appeared in any of these experiments and for this reason the separate records for manured and unmanured areas are not included in the Table.

That no effects of manuring have become manifest so far is by no means proof that manuring has been without benefit and further results are required before a conclusion on this question can be reached. In this connection it should be noted that no high-yielding tapping systems, as for example full-spiral fourth-daily tapping, have been used in these experiments. It is possible that any benefits from manuring would appear more rapidly when such systems are employed.

TABLE VIII.—*Tapping-cum-Manuring Experiments Nos. 31, 32 and 36. Summary of Yield and Girth Increment by Tapping Systems.*

The yield of the Control Tapping System (S/2, d/2, 100%) is expressed as lb./ac./ann and girth increment is expressed in cm. For the other Tapping Systems **relative values** *are given.*

Experiment Number	Year of Experiment. / Tapping system	First. Yield Rubber all grades	First. Girth Increment	Second. Yield Rubber all grades	Second. Girth Increment
31 Mixed P.B. Clones	S/2,d/2,100% Control	1,145 lb./ac.	2.55 cm.	1,251 lb./ac.	2.63 cm.
	S/2,d/2,6m/9, 67%	76	104	81	100
	S/2,d/1,m/2, 100%(1)	109	91	104	90
32 Clone B.D.5	S/2,d/2,100% Control	607 lb./ac.	3.03 cm.	775 lb./ac.	4.10 cm.
	S/2,d/1,m/2, 100%(2) (with flying start)	103	90	112	90
36 Seedling Rubber	V/2,d/2,100% Control	851 lb./ac.	2.22 cm.	821 lb./ac.	2.76 cm.
	V/2,d/2,6m/9, 67%	73	118	79	104

NOTES.—(1) Changed to S/2, d/2, 3w/6, 100% in second year, i.e., three weeks daily tapping followed by three weeks rest.

(2) Changed to S/2, d/2, 2w/4, 100% (with flying start) in second year, i.e., two weeks daily tapping followed by two weeks rest.

Effect of Tapping Systems.—The response to " A.B.C. " tapping (C/2, d/2, 6m/9, 67%) has been the same in these experiments as in those already reported where the system has been used.

In Experiments 31 and 32 daily tapping in alternate months was employed during the first year but during the second year the periods of tapping and rest were shortened to conform with the so-called " economic " periods described on pages 52 and 55.

In Experiment 31 this change appears to have resulted in a slight reduction in relative yield while in Experiment 32 there has been an increase of about 8 per cent.

4. Miscellaneous Tapping Experiments.

TAPPING OF MATURE BUDDED TREES OF THE PILMOOR CLONES; EXPERIMENT 37, PILMOOR ESTATE—

The original buddings of the Pilmoor Clones were tapped continuously throughout the year and the new panel opened at 40 inches from the union in January, 1937 was completed in December, 1940. Since July, 1937, tapping has been entirely on renewed bark. In the principal clones, Pilmoor B. 84 and D. 65, there have been no cases of disease or damage; the yield and girth records for the past six years are summarised in Table IX.

TABLE IX.—*Growth and Yield of the Original Buddings of Clones Pilmoor B. 84 and D. 65.*

Clone	B.84 (16 trees)						D.65 (4 trees)					
Year	1935	1936	1937	1938	1939	1940	1935	1936	1937	1938	1939	1940
Year of life	11th	12th	13th	14th	15th	16th	11th	12th	13th	14th	15th	16th
Girth in inches at 40″ from union	37.6	38.9	40.2	41.8	43.1	44.0	37.3	39.2	39.8	41.4	42.4	42.9
Yield in lb. per tree per year	19.2	21.5	17.7	19.4	21.1	20.9	23.2	23.0	17.6	21.2	22.0	21.6

These buddings have been tapped without rest alternate-daily on half-circumference (S/2, d/2, 100%) from May, 1930, after test-tapping during 1928 and 1929 on a lighter system. Following a drop in yield in 1937, when a new tapping cut was opened six inches above renewed bark, yields have increased to a fairly constant level of about 20 pounds per tree per year.

Comparison of the two tapping systems, alternate-daily (S/2, d/2, 100%) and daily alternate-monthly (S/2, d/1, m/2, 100%), on buddings of Pilmoor B. 84 was continued. It has been reported previously that for the first five years of tapping the daily alternate-monthly system gave higher yields than the alternate-daily system. During the

past five years the position has been reversed. Trees tapped on the daily alternate-monthly system are now smaller in girth by about 10 per cent. and give yields which are lower by 15 per cent. than trees tapped on the alternate-day system.

Influence of the Direction of the Tapping Cut on Yield of Budded Trees—

The experiment to compare left-to-right and right-to-left tapping on buddings of a clone of moderate yielding capacity, Clone Pilmoor B. 95, was completed in December 1940. As in seedling trees, it has been found that tapping from high right to low left results in a lower yield than is obtained by tapping from high left to low right. The mean loss in yield over a period of eight years amounted to nearly 13 per cent. The loss was greatest when tapping was at the highest level and tended to decrease as the tapping cut approached the union.

"Double-four" Tapping on Budded Trees—

Tapping Experiment 48 (*Field 5*, *R.R.I.E.S.*).—Tapping of budded trees of nine clones on the "double-four" system has now been compared with alternate-day tapping on a single half-circumference cut for a period of nearly six years. In the "double-four" system two cuts on half-circumference, one opened at 40 inches and the other at 20 inches on opposite sides of the tree, are tapped together every fourth day (2S/2, d/4, 100%). Although there are differences between clones in their response to this system the average result for all clones has been a loss in yield of about 10 per cent. In comparison with the full-spiral fourth-daily system the double-four system has little to recommend it.

Influence of Height of Tapping on Yield of Budded Trees—

Tapping Experiment 48, *R.R.I.E.S.*, *Field 5*.—This experiment completed its sixth year in December, 1940. Budded trees of nine clones were opened for tapping at heights of 20 inches and 40 inches early in 1935. The trees originally opened at 20 inches were tapped for three years on the first panel, and the second panel was opened at 40 inches on the opposite side of the tree. The trees opened originally at 40 inches completed five years tapping on the first panel and were opened at 40 inches on the opposite side at the beginning of sixth year. Comparing the total yields of the trees opened at 20 inches and 40 inches the mean difference in yield over six years amounted to 4 per cent. in favour of opening at 40 inches at the commencement of tapping. There have been interesting differences between clones but these do not affect the general conclusion reached in this experiment that budded trees can be safely opened for tapping at a height of 40 inches from the union without loss of crop, at least over the first six years of tapping. The tapping system in this experiment was alternate-day tapping on half-circumference (S/2, d/2, 100%).

Slaughter Tapping. Tapping Experiment No. 45 (Field 18C, R.R.I.E.S.)—

This experiment was fully described in the *Annual Report* for 1939, pages 121 to 124. Full-spiral tapping at different intensities has been used on a mixed planting of buddings and seedlings in a poor area which is to be replanted. The seedlings were nine years old and the buddings seven years old when the experiment was started in October, 1939.

It was expected when the experiment was planned that the most intensive systems, daily tapping on full-spiral and even alternate-daily tapping on full-spiral would result in rapid drying up of the trees and a very heavy incidence of brown bast. After 15 months of continuous tapping on these systems neither of these expectations has been realised.

In the most intensive systems the general tendency has been for yield to fall rapidly for about six months following an initial flush crop, while thereafter a fairly uniform yield level has been maintained. Dry-rubber-content of the latex has at all times been lower than in the control (S 2, d 2, 100%) but after the yield has reached the constant low level d.r.c. has commenced to rise. Incidence of brown bast was heavy during the initial flush period only in the most intensive system of daily tapping on full-spiral, where it reached a maximum of 13 per cent. Thus it appears that when trees are tapped continuously at high intensity on the *same cut* the latex system became progressively adapted to the method of tapping.

In the trees tapped daily on full-spiral one panel was completed in one year and a second panel opened 20 inches above the first panel. An immediate increase in yield greater than the flush recorded in the first three months of the experiment was obtained. The same rapid decline in yield after the flush has been observed.

In the less intensive systems the gain in yield has been smaller but d.r.c. has not fallen to so low a level. After 15 months tapping the total yield per tree on any of the intensive systems has not been more than 20 per cent. greater than the yield of the control trees tapped alternate-daily on half-circumference. For poor trees of the kind used in this experiment the economic advantages of slaughter-tapping have been small. Intensive tapping, such as full-spiral daily resulted in an increase in yield of about 60 per cent. over a period of three months. A similar increase in yield for a further period of three months may be obtained by opening a new cut at a higher level. On the other hand, full-spiral tapping every third day (S/1, d/3, 133%) gave about 10 per cent. higher yield than the control with a saving of about 12 per cent. in tapping cost and the d.r.c. of the latex remained normal over the full period of the experiment.

5. New Tapping Investigations undertaken during the Year.

Two new "single-task" experiments were laid down in the Bahau District Experiment No. 9 on clone Glenshiel 1 and Experiment No. 10 on P.B. 186. Preliminary yield trials were carried out from July to December in Experiment No. 9 and from August to December in Experiment No. 10. Comparative tapping records will be made from January, 1941, onwards. In design these experiment are similar to No. 8 but some of the tapping treatments have been modified to allow for the known characteristics of the clones.

Arrangements for a new experiment in Field 18A, R.R.I.E.S. (Tapping Experiment No. 49) were made, prior to the commencement of a preliminary yield trial in January, 1941. The purpose of this experiment is to compare full-spiral tapping system of various intensities on sixteen clones with regard to yield, girth increment and bark renewal both above and below the tapping cut. A modification of the cup-coagulation-recording method makes possible separate estimates of No. 1 and low-grade rubber. This is of importance in the study of full-spiral tapping since late dripping is a frequent cause of inconvenience in certain clones.

Preliminary work was also undertaken in connection with two new experiments on estates ; Tapping Experiment No. 60 in Pahang and No. 61 in Johore. The object of both experiments is to determine the effect of full-spiral fourth-daily tapping under the prevailing conditions on the estates. The experiments have been designed so that the field management will be simple and yet make possible a precise evaluation of the effects of the tapping system.

III. Selection and Breeding.

In the selection and breeding investigations reported below the standards adopted for tapping and recording of yields are as follows. Seedling trees are brought into continuous tapping when they reach a girth of 20 inches at 20 inches above ground level ; the corresponding standard for budded trees is 18 inches girth at 40 inches above the union. Alternate-day tapping with a left-to-right spiral cut on half-circumference, S/2, d/2, 100%, has been adopted as the standard tapping system and unless otherwise stated, the yields reported in the various investigations described in this section have been obtained on this system. Individual tree yields are recorded by the method of cup-coagulation on two tapping days chosen at random in each month. Yields are expressed as pounds dry rubber per tree per year on the basis of 160 tapping days.

New Clones from Estate Mother-Trees (Field 15 South, R.R.I.E.S.)—

Tapping of the 235 new clones made from high-yielding mother trees selected on estates was continued until the end of the year. It is clear that owing to their poor yields a large number of these clones can have no commercial value and it has been decided to continue recording the yields of only 75 clones which gave reasonably good yields during the first three years of test.

Under the scheme of experimental planting on estates, clone trials have been established and budwood has been sent to several estates for the further testing on a large scale of eleven of the clones in this series.

The yields of some of the best of the clones and of the control clone Avros 50, are given in Table X.

Clone Collection (Field 15 North, R.R.I.E.S.)—

The yields of a selection of the clones in this collection are also given in Table X. With a few exceptions these clones are now regarded as obsolete and the yields are recorded as a matter of interest only.

Breeding Investigations—

Details of the hand pollinations made in the 1940 flowering season are given in Table XI. For the second year in succession the results must be accounted very poor and the exceptionally dry weather in May and June again caused a considerable loss of fruits before they had matured. The general conditions for the production of seed were too poor for any estimate of the comparative fertility of the different crosses to be made.

A second attempt at the mass production of hand-pollinated seeds was made using Tamil boys as pollinators (Table XII). The two clones used, Tjirandji 1 and particularly B.R. 2, are normally good seed bearers and although the results are slightly better than those obtained in the main programme of crosses the germination was exceptionally poor.

The pollinators varied a great deal in the speed at which they worked, and averaged throughout the season 62 pollinations on each of the nineteen working days.

Legitimate Seedling Families obtained by Hand Pollination—

The yields during 1940 of the first seven series of hand-pollinated seedlings are set out in Table XIII. Although the tapping cuts of the first three series were on virgin bark low down on the tapping panels there has been a decline in yield in nearly all families. This is most marked in the crosses with clones Pilmoor A.44 and B. 58.

In the later series of crosses there has been a good increase in yield, this being particularly noticeable in the families B. 58. B. 84 ; D. 65. D. 61 and B. 84. G 1. The last family, with a yield of 13.5 lb. per tree at an average age of eight years and two months, has shown a steady rate of increase since it was first tapped in 1936.

Legitimate Seedlings from 1938 Crosses—

Twenty-three families consisting of 600 seedlings obtained by hand pollination were planted in October in the south-eastern part of Field 34. It is inevitable in work of this nature that the size of the families will vary within wide limits. In consequence it has been necessary to adopt a rather complicated experimental lay-out in which the seedlings are divided into 120 plots of five trees. The design of this lay-out was prepared by the Statistician.

New Clones from Legitimate Seedlings ("R.R.I.-500 Series")—

In Table XIV the yields of ten clones of the R.R.I. 500 series of which budwood has been sold for commercial purposes and of seven clones of a later selection are tabulated. The tapping cuts of all clones except 500 and 502 approached or crossed the union of stock and scion during the year. The effect of this on yield has varied greatly with different clones ; the yield of 506 has fallen badly and the yield of 514 by a small amount. Comparatively small increases are recorded for some of the other clones. The trees of clones 523 to 529 were pruned heavily for budwood early in the year and this has probably had an adverse effect on yield. The big drop in yield of clone 500 can be attributed to poor tapping and the excision of too little bark. The tapper was changed and the yield in December was at the rate of over thirty pounds a year.

A further eight clones have been selected from those made from the first seven series of hand-pollinated seedlings. These clones were required for use in experiments to be set up on peaty soil where the root anchorage is bad. For these experiments the clones selected were of erect habit with small compact crowns.

Distribution of Budwood—

A notice was published in the April number of the *R.R.I. Planters' Bulletin* stating that budwood of ten of the new R.R.I. Clones was available for sale to estates for commercial purposes. Previous distributions of budwood of these clones had been for experimental

purposes only. None of the clones can yet be described as proved and estates have been advised to plant small permanent plots with these clones to obtain first-hand experience of them under local conditions. Distribution of the budwood started in September and 3,900 yards were sold by the end of the year.

Clones from 1938 Crosses—

Five hundred and twenty-two new clones made from hand-pollinated seedlings of the 1938 crosses were established in Fields 34 and 44 in October. About ten planting points were budded with each clone and clone Pilmoor B. 84 was used as a control.

New Clones from Illegitimate Seedlings—

A small-scale trial was set up in Field 33A to test 37 new clones made from illegitimate seedlings growing on the Experiment Station. The clone mother-trees were selected from the highest-yielding trees in various fields as determined by periods of tapping ranging from six months to four years.

Yields of Illegitimate Seedlings of High-Yielding Clones—

The yields of several families of illegitimate seedlings in the older fields, like those of the legitimate seedlings, have shown a decrease during the year, although tapping has been continued on the same panels on virgin bark. To what extent this decrease in yield is due to the precocity of the trees or the unfavourable weather conditions cannot yet be determined. (Table XV).

The illegitimate seedlings tested in Field 25 (IV) were grown from seeds collected from the original buddings of the various clones on the estates where test-tapping was in progress, i.e., Prang Besar, Kajang, Sabrang and Glenshiel Estates. During 1940 the trees were tapped for the second year on the second panel opened at 30 inches in 1939. All families show a satisfactory increase in yield; seedlings of P.B. 49 are outstanding.

In Field 17D new tapping cuts were opened at thirty inches from the ground in July and with the exception of the seedlings of clones Pilmoor D. 65 and Avros 152 the yields remain about the same as in the preceding year. The original buddings of clone Pilmoor D. 65 were low yielders when first tapped and the seedlings appear to have inherited this characteristic, for their yields have increased more rapidly than those of the other families in this field.

Seedlings from Isolated Seed Gardens—

The seedlings from the Tjikadoe Isolated Seed Gardens (Table XVI) were tapped throughout the year on renewed bark near the base of the trees. As in the older series of legitimate seedlings there has been only a small increase in yield, which probably can be in part accounted for by the adverse weather conditions which prevailed over a large part of the year.

The effect on yield of tapping on renewed bark, varies considerably in the different families, satisfactory increases being recorded in some families such as 10, 11 and 23 and falls in yield of over ten per cent. in families 6, 12 and 22.

In Table XVII the yields of seedling trees from two other Isolated Seed Gardens are given.

TABLE X.—*Yields of New Clones from Estate Mother-Trees (Field 15 South).*

Yields of Clones in the Clone Collection (Field 15 North). Tapping System: S/2, d/2, 100%.

CLONES FROM ESTATE MOTHER-TREES.									CLONES FROM CLONE COLLECTION.								
Clone.	Yield in lb. per tree per annum 160 tappings.								Clone.	Yield in lb. per tree per annum 160 tappings.							
	1937.		1938.		1939.		1940.			1937.		1938.		1939.		1940.	
	Clone.	Av. 50.	Clone.	Av. 50.	Clone.	Av. 50.	Clone.	Av. 50.		Clone.	Av. 50.	Clone.	Av. 50.	Clone.	Av. 50.	Clone.	Av. 50.
R.R.I. 5*	3.5	4.4	6.7	5.0	10.8	5.6	13.5	5.8	Av. 150	6.1	3.1	9.0	4.4	11.4	5.4	13.4	6.6
24	6.5	3.6	6.5	4.5	9.2	6.0	11.9	6.5	Av. 163	5.3	2.5	9.2	3.7	12.0	5.5	15.3	7.0
27*	4.8	4.1	6.2	4.8	9.2	5.7	11.2	7.5	P.B. 24	4.6	4.3	7.2	5.5	9.6	4.4	9.5	5.2
28	4.2	4.5	6.3	4.0	9.4	5.4	9.5	6.6	P.B. 31	6.1	3.2	6.1	4.5	9.8	5.7	10.7	7.6
49*	5.4	4.0	7.1	5.4	9.8	5.2	11.6	6.4	P.B. 49	5.8	3.5	8.8	4.4	12.0	6.4	13.3	7.4
54	4.0	2.7	6.2	4.8	8.5	5.9	9.5	6.7	P.B. 86	6.2	3.8	9.2	6.1	9.0	4.5	11.5	5.1
83	3.6	2.5	6.0	4.3	8.3	5.5	11.8	7.2	P.B. 123	9.1	3.1	9.6	5.4	12.0	5.0	12.7	7.7
88	4.8	3.7	6.8	3.9	8.6	5.6	11.6	6.6	P.B. 155	7.1	2.8	9.8	4.4	9.9	3.9	10.8	5.7
99*	5.4	3.8	6.8	4.5	10.7	6.4	11.5	7.6	P.B. 183	3.8	3.1	5.8	4.0	8.7	3.9	10.5	5.7
103	7.0	4.4	6.2	5.3	9.9	6.4	11.6	6.3	Dj. 1	3.6	2.8	6.2	5.0	9.0	7.1	11.2	9.3
107*	5.4	3.8	7.8	4.4	11.5	4.4	16.3	5.0	P.E. 26	7.1	2.3	10.0	4.8	12.0	5.9	11.1	4.9
138*	5.9	3.3	6.0	4.4	9.0	4.4	9.4	5.8	B.R. 2	3.9	2.9	6.1	6.1	8.6	7.9	8.8	9.3
140	6.3	5.0	6.3	4.8	8.5	5.2	11.8	6.1	Lun. N	7.4	3.9	9.0	3.9	10.5	6.0	11.9	7.5
142*	6.8	3.5	7.5	4.4	11.5	5.3	13.2	8.0	R.A. 22	9.2	2.9	10.7	4.5	13.8	4.4	12.7	5.7
147*	7.7	4.1	7.6	4.0	8.6	5.6	9.1	6.9	R.A. 23	10.1	3.8	10.0	5.9	14.0	7.4	11.2	7.4
178*	—	—	4.5	2.5	9.5	4.6	11.0	4.6	Pil. B. 16	4.4	3.6	8.0	5.3	9.7	5.0	11.1	7.1
195*	—	—	4.9	3.6	8.1	4.4	9.5	5.8	G. 11	5.2	2.4	8.8	4.4	9.2	5.2	10.0	6.0
218*	—	—	3.0	3.0	6.3	3.1	6.8	4.1	K. 80	5.4	3.3	8.1	4.3	9.1	5.0	10.1	6.1

NOTE.—Clones marked* are being tested on a large scale in Estate Experiments.

TABLE XI.—*Results of Hand Pollinations 1940.*

No.	Cross.	No. of Pollinations.	No. of fruits Harvested.	Percentage Success.	No. of Seeds planted.	No. of Seeds germinated.	Percentage germination.
1	501 × 500	76	1	1.3	3	3	100
2	501 × 506	14	—	—	—	—	—
3	500 × Tj. 1 ..	62	—	—	—	—	—
4	Tj. 1 × 500 ..	615	6	1.0	18	13	72.2
5	B. 84 × 501 ..	130	7	5.4	22	14	63.6
6	B. 84 × 511 ..	110	5	4.5	15	9	60.0
7	Tj. 1 × 523 ..	227	5	2.2	15	13	86.7
8	B. 84 × 523 ..	245	1	0.4	3	—	—
9	Lund. N × 523 ..	10	1	10.0	3	—	—
10	Tj. 1 × 524 ..	222	9	4.1	27	22	81.5
11	B. 84 × 524 ..	94	1	1.0	3	—	—
12	Tj. 1 × 525 ..	207	3	1.4	9	5	55.5
13	Tj. 1 × 526 ..	213	9	4.2	29	28	96.6
14	Tj. 1 × 527 ..	453	17	3.8	51	49	96.0
15	Lund. N × 527 ..	252	—	—	—	—	—
16	Tj. 1 × 528 ..	206	23	11.2	73	65	89.0
17	Lund. N × 528 ..	245	3	1.2	9	—	—
18	R.A. 23 × 528 ..	188	—	—	—	—	—
19	Lund. N × 529 ..	176	—	—	—	—	—
20	Tj. 1 × 529 ..	291	9	3.1	27	22	81.5
21	R.A. 23 × 529 ..	197	—	—	—	—	—
22	Tj. 1 × Lund. N ..	287	5	1.7	13	10	76.9
23	Lund. N × B. 84 ..	5	—	—	—	—	—
24	B. 84 × Lund. N ..	17	—	—	—	—	—
25	R.A. 23 × Lund. N	15	—	—	—	—	—
26	R.A. 23 × 501 ..	118	—	—	—	—	—
27	501 × R.A. 23 ..	42	—	—	—	—	—
28	R.A. 23 × 511 ..	135	—	—	—	—	—
29	R.A. 23 × B. 84 ..	19	—	—	—	—	—
30	B. 84 × R.A. 23 ..	111	—	—	—	—	—
31	Tj. 1 × R.A. 23 ..	282	1	0.4	3	—	—
32	R.A. 23 × 500 ..	22	—	—	—	—	—
33	500 × R.A. 23 ..	31	—	—	—	—	—
	Totals ..	5317	106	2.0	323	253	78.3

TABLE XII.—*Large-scale Hand Pollination, 1940.*

Crosses.	No. of Pollinations.	No. of fruits.	Percentage success.	No. of seeds planted.	No. of seeds germinated.	Percentage germination.
Tj. 1×B.R. 2	459	9	2.0	603	270	44.8
B.R. 2×Tj. 1	5143	192	3.7			
Totals ..	5602	201	3.6	603	270	44.8

TABLE XIII.—*Yields for 1940 of the Legitimate Seedling Families of the 1928—1931 Series.*

Mean Yield in lb. per tree per annum estimated on 160 tappings.

Parents.	1st Series age on 1-1-40 10 years 8 months.		2nd Series age on 1-1-40 10 years 3 months.		3rd Series age on 1-1-40 9 years 8 months.		4th Series age on 1-1-40 9 years 3 months.		5th Series age on 1-1-40 8 years 8 months.		6th Series age on 1-1-40 8 years 3 months.		7th Series age on 1-1-40 7 years 8 months.	
	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.
A. 8 & A. 44	7	8.2	..	..	..	..	..	..	..	..	..	..	..	..
A. 8 & B. 58	21	10.6	..	..	..	..	..	..	..	..	..	..	..	..
A. 44 & B. 58	13	11.8	54	11.9	21-22	12.9	..	..	..	..	..	..	..	..
A. 44 & D. 61	73	12.8	35	14.3	106	14.1	..	..	..	..	..	..	..	..
A. 44 & B. 16	31	17.1	..	..	120	16.4	..	..	..	..	..	..	..	..
A. 44 & B. 84	7	22.0	30	16.5	43	14.7	87	11.8	..	..	..	..	..	..
B. 58 & D. 61	8	9.5	..	..	..	..	..	..	..	..	130	11.9	..	..
B. 58 & B. 16	11	15.3	..	..	7	23.4	..	..	..	..	..	..	..	..
D. 61 & B. 16	6	7.0	..	..	18	10.7	..	..	..	..	45	11.9	..	..
A. 44 & B. 50	..	..	18	10.0	..	..	..	..	..	..	..	..	..	..
D. 65 & A. 44	..	..	..	..	5	9.7	..	..	25	8.9	..	..	..	..
B. 50 & B. 58	..	..	25	9.2	..	..	..	..	..	..	..	..	..	..
B. 58 & B. 84	..	..	14	17.6	..	..	21-22	15.4	..	..	3	17.5	..	..
B. 84 & D. 61	..	..	52	14.2	..	..	..	..	..	..	..	..	..	..
B. 84 & B. 16	..	..	..	..	36	16.8	..	..	..	..	..	..	..	..
D. 65 & B. 16	..	..	..	..	9	14.1	..	..	1	10.8	..	..	..	..
A. 44 & B. 65	..	..	..	..	..	..	15	9.0	..	..	..	..	..	..
D. 61 Selfed	..	..	..	..	1	5.5	..	..	..	..	..	..	..	..

TABLE XIII.—*Yields for 1940 of the Legitimate Seedling Families of the 1928—1931 Series—(cont.).*

Mean Yield in lb. per tree per annum estimated on 160 tappings—(cont.).

Parents.	1st Series age on 1-1-40 10 years 8 months.		2nd Series age on 1-1-40 10 years 3 months.		3rd Series age on 1-1-40 9 years 8 months.		4th Series age on 1-1-40 9 years 3 months.		5th Series age on 1-1-40 8 years 8 months.		6th Series age on 1-1-40 8 years 3 months.		7th Series age on 1-1-40 7 years 8 months.	
	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.	No. of trees.	Mean yield.
D. 65 & B. 84	..	..	..	..	..	..	8	12.4	36	14.0	..	..	..	..
B. 50 & B. 84	..	..	..	..	..	..	17	11.9	..	..	..	..	..	..
B. 58 & D. 65	..	..	..	..	..	..	..	..	34	7.3	..	..	..	..
B. 58 & B. 65	..	..	..	..	..	..	2	12.1	..	..	..	..	..	..
C. 72 & B. 84	..	..	6	28.4	..	..	..	..	..	..	..	..	..	..
B. 58 & C. 72	..	..	3	27.0	..	..	..	..	..	..	..	..	..	..
B. 90 & B. 16	..	..	..	..	..	..	..	..	..	..	..	..	..	..
B. 50 & E. 95	..	..	3	11.8	..	..	..	..	19	9.4	..	..	..	..
B. 95 & A. 44	9	13.1	..	..	..	..	..	..	..	..	..	..	..	..
A. 44 & Lund. N ..	..	..	..	..	17	17.5	..	..	..	..	..	..	..	..
B. 84 & Lund. B ..	..	..	..	..	..	..	..	..	6	11.9	..	..	..	..
Lund. K & Lund. N ..	..	..	..	..	2	4.5	..	..	..	..	..	..	..	..
A. 44 Selfed	..	..	..	..	3	6.6	7	5.3	..	..	..	..	..	..
B. 58 & B. 90	..	..	..	..	3	13.1	..	..	..	..	..	..	..	..
D. 65 & D. 61	..	..	..	..	..	..	..	..	3	10.5	76	12.6	..	..
B. 11 & D. 65	..	..	..	..	..	..	..	..	7	6.4	..	..	..	..
D. 61 & G. 1	..	..	..	..	..	..	..	..	..	..	..	..	41-42	10.0
B. 84 & G. 1	..	..	..	..	..	..	..	..	..	..	..	..	15	13.5
B. 58 & G. 1	..	..	..	..	..	..	..	..	..	..	..	..	6	7.3

TABLE XIV.—*Yields of a Selection of Clones made from Legitimate Seedlings of the 1928—1931 Series.*

Clone.	Origin of Mother-Tree.	Date Budded.	No. of trees tapped.	Yield in lb. per tree per annum.				
				1936.	1937.	1938.	1939.	1940.
500	B.84 × A.44	Nov., 1930	3	13.1	15.9	21.0	24.5	14.6
			3.3.4.4.4.	13.1	15.9	17.9	21.0	15.7
501	A.44 × Lun.N	Oct., 1931	1	8.9	18.2	25.3	26.0	35.0
			2.2.2.1.1.	9.3	18.2	26.3	25.1	35.0
502	B.16 × A.44	Nov., 1930	3	9.1	10.1	15.4	20.6	22.6
			3.4.4.4.4.	9.1	8.7	13.5	18.8	20.3
505	A.44 × Lun.N	Oct., 1931	2	8.9	11.6	14.8	15.3	23.0
			3.3.3.2.3.	7.1	10.4	13.6	16.4	24.1
506	B.84 × A.44	Nov., 1931	2	6.5	11.8	15.5	22.5	14.1
			3.3.3.2.3.	7.6	13.8	16.1	22.5	16.2
509	A.44 × Lun.N	Oct., 1931	2	9.5	14.0	11.8	16.7	20.8
			3.5.5.5.5.	9.2	12.6	11.4	18.2	21.0
511	A.44 × B.16	Nov., 1931	3	8.1	14.0	16.4	19.2	20.1
			3.4.5.4.4.	8.1	13.3	14.2	16.9	17.7
512	B.84 × A.44	Jun., 1932	2	6.0	11.2	13.5	17.8	24.9
			2.3.3.3.4.	6.0	10.3	12.3	15.7	18.6
514	A.44 × B.58	Oct., 1931	4	7.1	16.0	18.2	20.4	20.0
			4.5.5.5.5.	7.1	14.6	15.1	17.6	16.8
515	A.44 × D.61	Oct., 1931	2	6.5	14.2	17.2	19.9	21.2
			3.3.3.2.5.	6.4	13.9	17.0	19.9	12.6
523	A.44 × B.16	Oct., 1931	3	5.2	11.4	14.2	18.2	19.3
			3.3.3.3.3.	5.2	11.4	14.2	18.2	19.3
524	A.44 × B.16	Oct., 1931	1	4.4	11.4	19.0	24.6	19.6
			1.1.1.1.1.	4.4	11.4	19.0	24.6	19.6
525	B.84 × D.65	Apr., 1933	2	..	7.5	14.9	19.3	14.9
			2.3.3.3.	..	7.5	11.9	15.6	13.2
526	B.84 × D.65	Apr., 1933	3	..	4.1	11.6	18.7	23.0
			3.3.3.3.	..	4.1	11.6	18.7	23.0
527	B.50 × B.84	Jun., 1932	3	..	8.2	14.5	24.5	26.5
			3.5.6.6.	..	8.6	11.5	18.7	19.7
528	B.84 × D.65	Apr., 1933	2	..	4.4	9.8	16.2	17.2
			2.4.4.4.	..	3.6	8.4	13.6	14.0
529	B.84 × D.65	Apr., 1933	2	..	..	9.3	15.5	20.1
			2.2.2.	..	..	9.3	15.4	20.1

NOTE 1.—Under the heading "No. of trees tapped" the upper figure refers to the number of trees tapped continuously throughout the whole period and the lower figure to the number tapped in each year. One tree of clone 505 and one tree of clone 512 were blown over towards the end of the year and the upper figures for the last few months of the year for these two clones should be 1 in each case.

NOTE 2.—Two figures are given for the yield of each clone in each tapping year. The upper figure refers only to the yield of those trees tapped continuously throughout the period shown (with the exception of clones 505 and 512—*see* note 1), the lower figure gives the yield of all the trees tapped including trees too small to tap in the first year and trees taken out of tapping in later years because of disease or wind damage.

Brown-bast:—Clones 506, 1 tree; 509, 1 tree; 511, 1 tree; 515, 1 tree.

Storm-damage:—Clones 502, 1 tree; 512, 3 trees; 526, 1 tree.

TABLE XV.—*Yield of Illegitimate Clonal Seedlings in various fields on the Experiment Station.*

Origin of family.	Field and date of planting.	No. of trees in tapping 1940.	Yield in lb. per tree per annum 160 tappings.					
			1935.	1936.	1937.	1938.	1939.	1940.
Pil. A. 44	Field 4 (A)	150-157	5.8	8.0	9.8	11.8	13.3	12.3
,, B. 58	April, 1929	77	4.6	6.4	8.3	10.5	12.7	12.0
,, B. 84		20	5.6	8.2	11.6	15.8	19.9	19.1
,, B. 16		8	2.7	5.3	6.3	7.4	12.1	10.6
Pil. A. 44	Field 16 (N)	62-63	3.8	5.1	8.8	9.2	12.8	13.0
,, B. 58	Nov., 1929	65-67	2.9	5.0	7.5	7.5	11.2	11.2
,, B. 84		147-148	4.0	7.0	10.5	11.0	15.8	16.6
Pil. A. 44	Field 16 (S)	28	3.6	5.6	8.8	8.8	12.0	12.3
,, B. 58	April, 1930	18-19	3.0	5.0	8.7	7.7	12.5	13.5
,, B. 84		11	2.5	5.2	9.0	7.2	12.8	11.4
,, B. 16		37	2.5	4.8	8.1	7.4	11.6	14.3
,, D. 65		46-47	2.3	3.6	6.7	7.7	12.3	12.9
P.B. 8	Field 25 (IV)	21-23	—	—	6.4	10.1	8.5	11.2
,, 24	Dec., 1931	20	—	—	5.3	8.1	6.9	8.6
,, 49		18	—	—	7.7	11.8	10.4	17.6
,, 86		40	—	—	6.5	10.7	9.6	13.8
S.R. 9		30	—	—	6.4	10.6	9.4	15.6
Sab. 24		20	—	—	5.9	9.6	9.0	14.8
Glen. 1		24	—	—	3.2	5.3	5.2	8.8
Pil. D. 65	Field 17D(N)	18-19	—	—	—	4.4	6.3	7.7
P.B. 24	Nov., 1932	15	—	—	—	5.5	7.9	7.2
,, 25		32	—	—	—	5.1	7.8	7.1
Glen. 1		32	—	—	—	3.8	5.9	6.0
Sab. 24		97-108	—	—	—	5.0	6.3	7.2
S.R. 9		92-98	—	—	—	5.5	7.5	7.6
Avros 50		16	—	—	—	2.3	4.0	4.1
,, 49		21	—	—	—	3.4	4.6	4.0
,, 152		20-23	—	—	—	4.9	6.1	7.2

TABLE XVI.—*Summary of Yield Records of Families of Seedlings from the Tjikadoe Isolated Seed Gardens. (Age 1940—11¼ to 12¼ years).*

Family.	Number of Trees Tapped.						Yield in lb. per Tree.					
	1935.	1936.	1937.	1938.	1939.	1940.	1935.	1936.	1937.	1938.	1939.	1940.
1	9	9	9	9	9	9	6.6	10.5	12.2	13.6	20.2	23.9
2	13	12	12	11	12	12	7.0	11.6	14.4	20.4	24.9	24.5
3	9	10	10	11	13	13	4.0	7.2	8.5	13.0	15.9	17.4
4	8	10	11	11	10	10	3.2	5.2	7.3	10.0	13.5	15.1
5	10	13	14	13	14	14	2.9	5.1	4.6	6.7	9.4	11.3
6	8	11	11	10	10	10	6.3	9.1	12.3	19.1	21.6	19.1
7	12	12	12	12	12	12	6.5	12.2	14.4	20.2	24.6	29.5
8	9	11	11	11	11	11	3.7	6.2	7.8	10.4	13.1	14.4
9	4	5	5	5	5	5	5.4	9.6	14.1	20.8	27.8	28.4
10	10	9	8	7	8	6	9.6	17.4	15.5	16.6	26.3	35.3
11	10	9	9	9	9	9	3.4	6.6	6.5	4.5	12.0	16.8
12	7	7	7	7	7	6	4.5	9.0	9.5	14.5	22.7	19.8
13	6	9	8	6	6	7	5.5	5.8	6.7	11.0	14.5	14.5
14	6	6	6	6	6	6	4.1	9.4	11.9	18.7	21.9	23.1
15	14	13	13	13	12	11	7.0	11.1	14.3	20.4	28.6	25.9
16	4	7	6	6	8	8	3.6	4.7	7.0	8.8	10.5	11.7
17	9	10	8	9	10	10	8.4	12.2	21.7	26.4	29.4	33.4
18	10	10	10	10	10	10	4.3	7.2	9.2	13.2	15.0	15.0
19	12	13	13	13	13	13	4.6	7.1	8.6	11.8	17.8	17.8
20	15	15	11	13	14	13	9.2	16.8	18.4	23.7	32.9	32.2
21	6	8	8	8	8	8	11.3	9.6	12.0	15.8	23.2*	23.7
22	9	9	9	9	9	8	5.6	10.8	14.0	24.8	29.6	25.0
23	9	9	9	9	8	8	5.2	7.7	9.4	14.0	16.2	21.0
24	9	10	10	11	12	12	5.5	8.7	11.5	16.3	20.9	24.6
25	7	7	7	8	8	8	3.1	3.7	5.2	10.0	15.1	16.2
All Trees	225	244	237	237	244	239	5.5	9.0	11.1	15.4	20.3*	21.6

* In the 1939 report the mean yield of all families and the yield of family 21 were given in error as 20.5 lb. and 29.1 lb. respectively.

TABLE XVII.—*Yields of Seedlings from Isolated Seed Gardens in various Fields on the Experiment Station.*

Mother trees.	Field.	Date of planting.	Isolated seed garden.	No. of trees in tapping 1940.	Yield in lb. per tree per annum in 1940.
Av.157	9 A	Nov., 1933	Batu Kawan	232-243	5.6
Av.157	20 A	Nov., 1933	Batu Kawan	54-56	6.8
P.B.25	,,	,,	,, ,,	48-49	6.6
B.D.5	,,	,,	,, ,,	36-41	6.4
P.B.186	,,	,,	,, ,,	31-38	5.3
Av.256	,,	,,	,, ,,	40-44	6.1
Av.49	,,	,,	,, ,,	44-47	7.7
P.B.23	,,	,,	,, ,,	40-45	8.7
Sab.24	,,	,,	Changkat	37-40	6.0

Considerable variation in the yields of the different seedling families from each garden is apparent. From the Tjikadoe garden the highest-yielding family gave an average yield of over 30 pounds per tree which was about treble the yield of the lowest-yielding family. Similarly in the families from the Batu Kawan Seed Garden the family from clone Prang Besar 23 yields 64 per cent. more than the lowest-yielding family derived from P.B. 186.

EARLY DETERMINATION OF YIELDING QUALITIES OF SEEDLINGS—

As in previous years the relation between the annual yield in 1940 and yields obtained in the ten-day test applied at various ages from $3\frac{1}{4}$ to $5\frac{3}{4}$ years has been investigated for the group of seedling trees, principally Tjikadoe seedlings, in Field 2. In 1940 tapping was on renewed bark of the short panel used for the investigation of methods of test-tapping from 1932 to 1934.

The values of the correlations for yields at test-tapping and subsequent yields are tabulated below.

TABLE XVIII.—*Relationship between Yields at Test-tapping and Yields obtained in Continuous Tapping.*

No. of test-tapping.	Age of trees at test-tapping years.	Correlation between Yield at Test-tapping and Yields in Continuous tapping.					
		$6\frac{1}{4}$-$7\frac{1}{4}$ years.	$7\frac{1}{4}$-$8\frac{1}{4}$ years.	$8\frac{1}{4}$-$9\frac{1}{4}$ years.	$9\frac{1}{4}$-$10\frac{1}{4}$ years.	$10\frac{1}{4}$-$11\frac{1}{4}$ years.	$11\frac{1}{4}$-$12\frac{1}{4}$ years.
1	$3\frac{1}{4}$	+0.77	+0.68	+0.58	+0.46	+0.48	+0.40
2	$3\frac{3}{4}$	+0.75	+0.76	+0.64	+0.53	+0.53	+0.47
3	$4\frac{1}{4}$	+0.85	+0.77	+0.69	+0.69	+0.60	+0.49
4	$4\frac{3}{4}$	+0.83	+0.86	+0.65	+0.54	+0.54	+0.47
5	$5\frac{1}{4}$	+0.80	+0.80	+0.70	+0.59	+0.62	+0.61
6	$5\frac{3}{4}$	+0.85	+0.83	+0.74	+0.64	+0.64	+0.59

It will be noted that the values of the coefficients have fallen in 1940 indicating that the close relationship between yields at test-tapping and yields during the early years of continuous tapping has not been fully maintained. It seems likely that tapping on renewed bark may be partly responsible for this.

IV. Physiological Investigations.

NUTRITION: POT-CULTURE EXPERIMENTS WITH RUBBER PLANTS.

The study of growth and foliage characters of *Hevea* plants (budded stumps of Clone Tjirandji 1) when grown in sand-cultures supplied with various culture solutions has been continued. Early observations were reported in the Annual Reports for 1938, and 1939 (page 141).

Characteristic leaf symptoms of extreme deficiencies of nitrogen, phosphorus and magnesium have been in evidence throughout the year. No characteristic symptoms of deficiencies in calcium or potassium have yet appeared.

A possible explanation of the non-appearance of calcium-deficiency symptoms is that sufficient calcium (0.1 per cent. Ca), present in the sand medium as fragments of shell, remains to satisfy the plant requirements of that element. The absence of leaf symptoms of potassium deficiency after two years growth in a potash-deficient medium is surprising and one is forced to the conclusion that the well-grown budded stumps used in this experiment had a fairly high potash content which, owing to the great mobility of the potassium ion in the plant, has not been sufficiently reduced to produce leaf symptoms characteristic of deficiency of this element.

In March, 1940, six plants in each series were sampled for analytical work. The plants were selected at random in each series and the following sets of samples prepared from each plant. Leaves of different age groups were sampled for the determination of carbohydrates, nitrogen, phosphorus, potash, magnesium and calcium. Samples of bark, wood and roots were also prepared.

Records of the weight of leaves, shoots and roots, excluding the original "stump," were taken (*see* Table XIX).

The tops of the remaining plants in all series were cut back at six inches above the union of scion and stock.

TABLE XIX.—*Growth data for Budded Stumps of Clone Tjirandji 1 grown in Sandcultures.*

(*Data expressed as averages per plant*).

Treatment.	Shoots (stems and leaves).		Leaves only.		Roots.		
	Total Wt. gm.	As % of Series A.	Total No. of leaves.	Average Wt. per leaf gm.	Total Wt. gm.	As% of Series A.	Ratio $\frac{\text{tops}}{\text{roots}}$.
A. Complete nutrient	1,016	100	112	3.9	1,006	100	0.98
B. Nitrogen omitted	102	10	30	1.6	206	20	0.57
C. Phosphorus ,,	211	21	70	1.5	542	54	0.52
D. Potassium ,,	942	93	114	3.5	916	91	0.98
E. Calcium ,,	1,112	109	98	4.0	1,143	114	0.94
F. Magnesium ,,	826	81	78	3.6	891	89	0.97

Plants in Series E, calcium omitted, have made slightly better growth than those in the complete nutrient series. The striking effects of deficiency in phosphorus are amply demonstrated; it may be noted that the effect of phosphorus starvation appears to be relatively greater on the shoot system than on the root system.

TREATMENT WITH PALM OIL FOR THE STIMULATION OF BARK RENEWAL IN HEVEA—

Experiments on the effect on rate and quality of bark renewal of weekly and fortnightly applications of palm oil on young renewing bark have been continued. The marked stimulation in rate of renewal during the first year which has been reported previously has been confirmed by further experiments on buddings and seedlings. In

the oldest experiments, however, there is a strong indication from later measurements that the marked early stimulus in rate of renewal is not maintained. After two years the total thickness of renewed bark on the untreated control trees is not much inferior to that on the treated trees. Fortnightly applications of palm oil give practically the same result as weekly applications.

Treatment of Seeds with Growth Substances—

(*a*) *Hevea Seed.* Mixed clonal seeds were removed from the germination beds when the radicle was about half-an-inch long and soaked in solutions of Azeta (50 : 50) for $\frac{1}{2}$ hour, Hortomone A (1 in 320), Seradix A (strength E) and tap water for 24 hours prior to planting. There were 265 seeds in each treatment.

The results, ten months after planting, show better growth of seedlings in the Azeta treatment during that period, no difference in growth between Seradix A and tap water treatments and a delayed effect of Hortomone treatment, which, starting on level terms with tap water treatment, had passed it six months after planting and seemed to be catching up with Azeta treatment at the time of the latest height measurements taken on the last day of the year.

Statistical analysis has shown that the effect of treatment with growth substance on percentage survival is highly significant ($P < 0.01$). Azeta treatment has increased the percentage survival but this effect just fails to reach the 5 per cent. level of significance. Hortomone "A" and Seradix "A" treatments have reduced the percentage survival and this effect, which suggests that the dilutions used were toxic, is shown to be statistically significant ($P < 0.05$).

(*b*) *Cover Plant Seeds.* Seed of fourteen species of creeping and bush leguminous cover plants were treated with 0.01 per cent. solutions of the synthetic auxins β-indolyl-acetic acid, β-naphthalene-acetic and β-indolyl-butyric acid and with tap water for 24 hours at room temperature and at 50° C. before planting in sand medium contained in shallow pans. Five hundred seeds were used for each treatment.

The results show no significant effect of growth-substance on the percentage germination two weeks after planting.

The percentage germination was very low in most cases, ranging from 55 per cent. for *Calapogonium mucunoides* to 0.9 per cent. for *Crotalaria usaramoensis*, with an average of about 8 per cent. for all tests carried out.

Treatment at 50° C. proved beneficial only with seed of *Centrosema pubescens* (55 per cent. increase in germination) and of *Pueraria javanica* (76 per cent. increase in germination). Seeds of other species tested were adversely affected by the treatment.

V. Ecological Studies.

CULTIVATION OF RUBBER TREES IN ASSOCIATION WITH INDIGENOUS COVERS AND LEGUMINOUS COVERS—

No change in the treatments has been made during the year in the experiment in Field 27 on the R. R. I. Experiment Station.

Treatment I—Natural covers (System A) minimum control. It became increasingly evident that growth of the rubber trees in plots under this treatment was suffering from competition of the vigorous small tree species which have been retained. Ground cover under the dense shade is very sparse but seedlings of the following species were noted : (the numbers in brackets refer to the index number of the drawings of these species in the revised edition of R. R. I. Planting Manual No. 6) *Anplectrum divaricatum* (2), *Antidesma cuspidatum* (3), *Baccaurea parvilflora*, *Carallia* sp., *Cyathostemma viridiflora*, *Ficus fistulosa* (36), *Pettacalyx saccardianus* (62), *Phyllanthus frondosus* (63), *Psychotria viridiflora* (66), and *Randia* sp.

In May, 1939, half-plots under this treatment were cleared of all natural covers and *Centrosema pubescens* was sown. Although slow to become established a fair sprinkling of vigorous young plants developed. A second sowing was made in November, 1940.

Treatment II—Natural covers (System B) controlled by slashing every six months, soft ferns retained.

The principal species remaining are *Nephrolepis biserrata*, creeping fern, and species of wild ginger. Amongst these the weakened remains of small tree and shrub species still survive and seedlings of the species listed under Treatment I above are also present.

Treatment III—Natural covers controlled by slashing at 4 feet at intervals of six months and all ferns, including Nephrolepis, removed.

No apparent changes in conditions in the plots under this treatment were noted. The covers have become weaker under the increasing shade but a fair cover still survives. Seedlings of a number of species which are able to thrive in shade began to appear in fair numbers towards the end of the year. Seedlings of the following species were most frequent: *Phyllanthus frondosus*, *Ficus fistulosa*, *Anplectrum divaricatum* and *Melastoma* spp.

Treatment IV—Leguminous bushes. A few plants of lamtoro (*Leucaena glauca*) survive under fairly heavy shade in all plots. *Desmodium ovalifolium* after a severe set back from eelworm attack has developed vigorously and forms a very satisfactory cover in many parts of the area under this treatment. *Clitoria cajanifolia* is abundant, having developed freely from self-sown seeds but the plants are for the most part weak and straggling and do not provide an effective soil cover.

Treatment V—Creeping legumes. Pueraria and Calapogonium have practically disappeared. *Centrosema pubescens* became very thin but has responded vigorously to an application of phosphate in November, 1939. (Application, 2 cwts. per acre broadcast).

TABLE XX.—*Cultivation Experiment (Field 27, R.R.I.E.S.). Growth and Yield Data for 1940.*

Treatments.	Mean girth April inches.	Yield on test-tapping. Jan. 1940 gm. per tree for 5 tappings.	Yield in lb. per acre July-Dec. (6 months).
I. Natural covers. System A. Minimum control. Lalang, Stagmoss and Bracken removed. Jungle trees growing more vigorously than the rubber lopped where necessary. No other treatment. Each plot was divided into two in May, 1939. In half the sub-plots the covers were cut back to ground level, mulched and planted with Centrosema. No change was made in the other sub-plots.	18.04	26.87	216.6
II. Natural covers. System B. Slashed every six months to 3 feet. Lalang, Stagmoss, Bracken and Blechnum eradicated.	18.75	29.94	238.3
III. Natural covers. System C. Similar to II but all ferns eradicated.	18.72	27.37	235.2
IV. Leguminous shrubs planted November, 1934. Desmodium ovalifolium and Clitoria cajanifolia planted above and below terraces, May, 1936. Bush covers slashed April, 1940.	18.10	25.76	215.6
V. Leguminous creeping covers. Planted December, 1934.	18.96	26.73	226.2
Standard error	0.169	1.429	
Significant Difference (5%)	0.506	4.282	

This is a randomised block experiment with five replications of each treatment.

Growth and Yield of the Rubber Trees.

The seedling trees were test-tapped on the ten-day system in January, 1940, when the trees were five years of age and girth measurements at 40 inches from the ground were taken in April. The results which are set out in Table XX show that the differences in growth are not large. The best growth was obtained in the plots of Treatment IV planted with leguminous covers but this does not differ significantly from II and III in which controlled natural covers are growing. Treatment IV, with leguminous bush covers, and Treatment I, under natural covers with minimum control, show the poorest growth and differ significantly from the other three treatments. The mean yields per tree at test-tapping in the five treatments are in the same order as the girths, but in this case the differences are not significant.

The original stand of 180 trees to the acre was reduced to 125 in March on the results of test-tapping.

Regular tapping of the seedling trees, S/2, d/2, 100% commenced in July and the yields for the first half year of continuous tapping are included in Table XX. The trees budded in the field in April, 1935, were not large enough to tap and it is not expected that they will be ready before July, 1941.

The standard error of the experiment has not been calculated but it is probable that the differences between treatments are not yet significant. However, it may be noted that Treatment V, leguminous creeping covers, which had the best growth has fallen to third place, its yield being exceeded by those of the two treatments with controlled natural covers.

Five types of planting materials were used in this experiment.

1. Clonal seeds from a monoclone area of Avros 49.

2. ,, ,, ,, Avros 50.

3. Unselected seeds. Collected from seedling areas on the Experiment Station.

4. Mixed clonal seeds. Equal quantities of seeds of the following clones : Avros 49, 50, 152 ; B. D. 10 ; A. 44 and B. 58. The first four types were obtained from a field of mixed buddings on an estate and the last two from the Pilmoor Estate experimental area.

5. Buddings of clones P. B. 186, B. D. 5, Tj. 1, B. 84 and D. 65.

The yields of the seedling plots from the second half of 1940 are given in Table XXI.

TABLE XXI.—*Yield of Seedling Trees in Field 27, for the period July to December, 1940.*

(No. 1 rubber only), tapping system; S/2, d/2, 100%.

Type.	Yield for 6 months in pounds per acre.
1. Clonal seedlings Avros 49	264
2. ,, ,, Avros 50	183
3. Unselected seedlings	162
4. Mixed clonal seedlings	296

VI. New Field Experiments on the R.R.I. Experiment Station.

The new areas planted during 1940 consist of small sections of the reserve area originally contained in the elephant belt. The details of these areas which will be used in 1941 for small-scale experiments are included in the report of the Manager of the Experiment Station.

VII. Field Experiments on Estates.

Opportunity was taken of the area made available under the second restriction scheme to set up further experiments for testing the later selections of R.R.I. clones on a field scale. Five estates in different parts of the country are co-operating in this extension to the experimental planting scheme, and the experiments, comprising a total of 185 acres, were planted during 1940 with estate seed preparatory to budding in the field.

Three other estates were selected for experiments on soil problems to cover a total area of 150 acres.

With one exception all experiments planted with ordinary seed during the period 1936—38 are now budded, the one uncompleted being largely replanted owing to serious damage by elephants. Preliminary growth records were taken in a few of the earliest experiments, but the data are at present too few to merit publication and it is proposed to wait until figures are available from all experiments of a particular scheme before attempting to discuss the results.

WEATHER CONDITIONS—

Total annual rainfall figures may not have shown much divergence from the average in many parts of the country, but in distribution of rainfall it cannot be said to have been a normal year. The first three months were exceptionally dry, and particularly in Kedah and Kelantan serious drought was experienced. June and July were also abnormally dry months in most districts. The latter part of the year was distinguished for its exceptionally heavy downpours, causing serious floods in some places (South Perak).

Following on the two dry years of 1938 and 1939 the very dry conditions in the early part of 1940 had the effect of retarding growth and development in young clearings, especially those budded late in 1939. Supplying was in consequence heavy in some of the experimental plantings.

The onset of heavy rains after a prolonged drought was partly responsible for the prevalence of bark-bursts particularly in the coastal districts. Clone Pilmoor B. 84 and to a lesser extent P.B. 86 were especially prone to this disorder. It is most likely that wind-strain also contributed to the occurrence of these bark-bursts, more particularly in the case of Pilmoor B. 84 whose heavy crowns are more liable to be bent over by the wind. The sudden flush of growth after protracted dormancy also caused numerous lateral shoots to develop in buddings one or two years old, which necessitated careful pruning.

Stock Experiments—

All three experiments have now been budded. The first growth record has been taken in one experiment.

Planting Material—

Whenever the opportunity arose in the course of routine visits of inspection, general observations on the growth characteristics, bark, etc., of the wide range of clones and clonal seedling families under test were made. Vigour and branching habit with particular reference to wind-resistance were the two most important points noted.

Amongst the proved clones, *Glenshiel 1* is proving to have greater vigour on some inland soil types than was expected from earlier observations, and its freedom from defects of branching and its strong resistance to wind damage make it a very suitable clone, with regard to secondary characters, for inland estates on more fertile soils, as well as on estates in the coastal districts for which it has been mainly recommended in the past.

Under similar conditions *Pil. D. 65* and *B.D. 5* are decidedly more backward. *Pil. D. 65* which is well known for its habit of premature wintering has probably suffered more than any other clone from the exceptionally dry spells of weather. *Tjirandji 16* and *P.B. 86*, which belong to a slightly more vigorous class, both seem very susceptible to soil conditions. While more vigorous clones, such as *P.B. 25*, *Tj. 1*, and *Pil. B. 84*, are available, the use of Tj. 16 and P.B. 86 should be confined to the more fertile soils.

In experimental areas budded in 1938 or earlier, buddings of Pil. B. 84 have reached or passed the stage when their early slow growth rate is succeeded by heavy branching and rapid girthing. Careful pruning of superfluous branches is then necessary and special instructions have been issued for use by estates.

The majority of clonal seedling trials were planted at irregular intervals, often late in the year, and have thereby suffered in lack of uniformity. The differences between families on this account are, however, rapidly evening out, and all areas are fully supplied. None of these experiments is old enough yet for comparisons to be drawn between families or between the clonal seedlings and their budded controls, but on the better soils the differences appear to be smaller than might be expected.

Experiments on Methods of Planting—

The seed-at-stake plots of the 73-acres experiment laid down to compare the value of budding in the field with planting of budded stumps, and stumped buddings, were budded early in the year—18 months from planting—thus completing all preparatory work. All four types of planting material are making good progress, and this experiment promises to yield results of great interest in the future.

At one of the substations, situated on coastal clay soil, the opportunity arose of comparing budded stumps with seedlings budded in the field. The ordinary estate seed and the budded stumps were planted at the same time, and the former budded in the field a year from planting. The first comparable measurements were taken in December, 1940, three years after planting, and revealed the interesting fact that the mean girth of five clones budded in the field was less than that of the budded stumps of the same clones by the equivalent of only three months' growth.

It is often claimed for budded-stump planting that a gain of nine months to one year in the time taken to reach maturity is obtainable. In certain circumstances it may be possible to achieve such a saving in time and overhead expenses, but under the conditions of these experiments, which are regarded as generally the most favourable for budded tumps, this is clearly not the case.

Furthermore, with the more vigorous and early-branching clones, such as *Pil. B. 84*, *P.B. 186* and *Tjirandji 1*, the difference between the two types of planting material was equivalent to less than three months' growth, the average difference being increased by the slower, late-branching clones Pil. D. 65 and B.D. 5. This fact suggests the possibility that the difference will decrease with advancing maturity of the rubber.

Clone Trial on Peat Land—

One experiment (50 acres) designed to compare the merits of a number of "agency" clones has had to be abandoned as such, on account of the impossibility of obtaining an economic stand of trees because of very unfavourable soil conditions. The exceptionally deep peat soil in this area provides conditions inimical to the growth of rubber, which are now being studied by the Soils Division.

Catch-crop Experiment—

Soil conditions have greatly improved in the two areas where this experiment is in progress. In one area this is mainly due to extra drainage ; in the other to consolidation of the surface peat layers, and the fact that the rubber roots have now reached the underlying clay.

Both derris and pineapples have responded well, and from preliminary observations it appears that the growth of rubber trees with these catch-crops is slightly better than under *Centrosema*. The retardation of growth of the rubber trees in the plots where one crop of tapioca was taken is now less marked than before.

Records of the pineapple harvests have had to be abandoned owing to pilferage. Sample harvest records of the derris crop are to be taken shortly, but the remainder of the crop will be allowed to continue growth in order to observe the effect on it of shade from the rubber. Derris forms an excellent soil cover.

Pests and Diseases—

The majority of the experimental areas are now past the stage of danger from rats and other vermin. Main concern now centres in root-disease and white-ant control.

A particularly severe case of white-ant attack deserves mention. The soil is a poor, peat-clay type and growth of the rubber has been slow. Losses from white ants have in some parts been over 50 per cent. and complete replanting will probably be necessary in these sections. Mortalities have been heavier in P.B. 86 than in the more vigorous Pil. B. 84, and it is noticeable that attacks are more severe—possibly through failure of the rubber to survive control measures—where the soil is poorest and growth backward.

In spite of the extra work placed on managers by staff absences on military duty, upkeep and record work have continued satisfactorily and we wish once again to record our thanks to them for their co-operation.

VIII. Advisory Work.

Correspondence—

An analysis of the correspondence dealt with by the Division appears as an Appendix to the Director's report. Nearly 3,000 enquiries were dealt with by letter, the principal subjects of enquiry being choice of planting material for use in replanted areas, enquiries on tapping and matters concerned with the progress of experiments on estates.

Circulars and leaflets on some of the principal subjects of enquiry were freely used and those in current use at the end of 1940 are listed below.

Circulars (botanical subjects).

No. 4. Notes on Bud-grafting.
5. Notes on Clones.
6. The Description and Lay-out of Seed Gardens.
12. International Notation for Tapping Systems (Revised version : May, 1940).

Advisory leaflets.

B/AL. 1 Replanting. Choice of Clones for Use in Replanted Areas.
,, 2 Notes on Killing of Rubber Trees with Sodium Arsenite.
,, 4 Notes on the Care of Budded Trees of Clone Tjirandji 1—Pruning.
,, 5 Wintering in Clone Tjirandji 1 and its Effect on Yield.
,, 7 Notes on Tapping of Clone Glenshiel 1.
,, 9 Notes on Lay-out and Recording in Field Experiments on Rubber.
,, 10 The "Testatex" method of Nursery Selection.
,, 11 Promising New Clones developed in Sumatra and Java.
,, 12 Stimulation of Rooting of Hevea Stumps by treatment with Plant Hormones.
,, 13 Notes on Full-Spiral Tapping.
,, 14 Preparation and Planting of Budded Stumps in Baskets.

Identification of Clones on Estates—

The services of the Institute's Field Assistants for the identification of clones in budwood nurseries on estates have been in great demand throughout the year, visits being made to 140 estates.

Visits to Estates and the Experiment Station—

Member of staff.	Nature of Visit.				Total.
		Research.			
	General advisory.	Experiment Station.	Estates.	Experimental planting on estates.	
C. E. T. Mann ..	33	22	1	27	83
C. C. T. Sharp ..	9	68	—	9	86
E. R. Guest	1	13	13	—	27
E. D. C. Baptist ..	2	16	3	8	29
N. Wright	21	1	—	19	41
R. S. Russell	—	5	30	—	35
K. N. Kaimal ..	3	29	30	6	68
T. V. Vaidyanathan ..	—	112	—	—	112
Totals ..	69	266	77	69	481

Interviews at the Institute—

Visits by planters to the Division to discuss points on which advice and information were required totalled 126.

Lectures in 1940—

Venue and date.	Subject.	Lecturer.
Batu Anam and North Johore I.S.P.—6th January, 1940	Tapping Systems	C. C. T. Sharp
Taiping Branch I.S.P.—29th March, 1940	Tapping Systems	E. R. Guest
Central Pahang Branch I.S.P.—10th March, 1940	The Choice of Planting Material	N. Wright
Central Perak Branch I.S.P.—13th March, 1940	Clonal Seeds and Buddings	N. Wright

LECTURES IN 1940—(*cont.*)

Venue and date.	Subject.	Lecturer.
Kuala Langat District Planters' Association, Banting—17th April, 1940	Problems of Current Interest on Estates	C. E. T. Mann
South Johore—Riow Branch I.S.P., Kota Tinggi—26th May, 1940	Improvement of Rubber by Breeding and Selection	C. E. T. Mann
Nilai—Labu Branch I.S.P., Sepang—9th May, 1940	Choice of Planting Material	C. C. T. Sharp
Klang District Planters' Association, Klang—25th May, 1940	The Performance of Budded Trees of Proved Clones	N. Wright
Lower Perak I.S.P., Teluk Anson—14th June, 1940	The Choice of Planting Material	C. E. T. Mann
Central Perak Estate Asiatic Staff Association—23rd June, 1940	Plant Ecology in Estate Practice	K. N. Kaimal
Central Kedah Branch I.S.P., Sungei Patani—22nd October, 1940	Problems of Current Interest on Estates	N. Wright

(I.S.P.=Incorporated Society of Planters)

TOURS—1940—

In North Johore	C. C. T. Sharp	— January	— 5 days
„ Selangor, „ Perak, „ Province Wellesley, „ Kedah	N. Wright	— March	— 9 „
„ Johore, „ Malacca	C. E. T. Mann	— May	— 4 „
„ Johore, „ Negri Sembilan	E. R. Guest, R. S. Russell	— May	— 4 „
„ Perak	C. E. T. Mann	— August	— 4 „
„ Pahang	C. E. T. Mann	— August	— 3 „
„ Perak, „ Kedah	N. Wright	— October	— 4 „
„ Perak	R. S. Russell	— November	— 3 „

Owing to the incidence of leave and military training it was necessary to curtail arrangements for extended tours of visits to estates. Whilst on long leave Dr. Baptist visited the Laboratories and Experiment Stations of the Proefstation, West-Java, and of the Sugar Cane Research Stations of Reduct, Mauritius, and Mount Edgecumbe, Natal, South Africa.

PUBLICATIONS—

Amendments and Additions to The International Tapping Notation.

Evan Guest, *J. Rubb. Res. Inst., Malaya*, Vol. 10, Communication 246.

International Notation for Tapping Systems. Revised Version May, 1940.

Evan Guest, *J. Rubb. Res. Inst., Malaya*, Vol. 10, Communication 247.

Progress of Breeding Investigations with Hevea Brasiliensis.

C. C. T. Sharp, *J. Rubb. Res. Inst., Malaya*, Vol. 10, Communication 248.

Improvement in the Quality of Rubber Planting Material.

C. E. T. Mann, *J. Rubb. Res. Inst., Malaya*, Vol. 10, Communication 251.

The Uses and Control of Natural Undergrowth on Estates. Revised Edition of Planting Manual No. 6, Dec., 1940.

(The Botanical Division undertook the revision of much of the text matter in this revised edition and included an account of the development of new rubber areas from jungle under systems of cultivation with indigenous covers).

C. E. T. MANN,
Head of Botanical Division.

KUALA LUMPUR,
October, 1941.

ANNUAL REPORT.

PATHOLOGICAL DIVISION.

STAFF—

Mr. F. Beeley, Head of the Division, proceeded on long leave to Australia on April 17th returning to duty on December 4th. Mr. R. P. N. Napper who was on duty throughout the year acted as Head of the Division during Mr. Beeley's absence.

Mr. L. D. E. F. Vesey FitzGerald has dealt with all entomological problems occurring during the year. This work has now been greatly facilitated by the completion of an insectary in a separate building east of the main laboratories.

Mr. K. P. John continued his valuable services throughout the year. Mr. H. C. Chuan, the Institute's Artist and Photographer, was on long leave for 4½ months during the year and during his absence Mr. Chan Tham Yew his assistant ably carried out his duties. We again record our appreciation of the assistance given by the Asiatic Staff both at the laboratories and at the Experiment Station during the year and of the assistance so kindly given to us by those estate managers and staffs who have carried out field experiments for us.

We are grateful to the Department of Agriculture, the Forest Research Institute, the Institute for Medical Research, the Director, Selangor Museum and the Imperial Institute of Entomology for their assistance in various problems.

GENERAL REMARKS ON PROGRESS OF RESEARCH—

The main subjects receiving attention during the year were root-disease control in replanted areas ; chemical killing of old rubber trees preparatory to replanting with a view to reducing the rate of spread of root parasites in the old roots left in the soil after normal felling ; the life history of various pests of rubber areas : cockchafers, termites, leaf-eating beetles, scale insects and various bark and leaf-eating caterpillars ; the bacteriology of legume nodule organisms and the bacteriology of latex preservation.

The weather during the early part of the year was ideal for the wintering and refoliation of rubber trees, consisting of a short spell of wet weather then a long period of bright, dry weather which enabled the trees to obtain their new leaves well before the break in the weather which normally occurs in April. Later in the year a return to very wet weather enabled further work to be done on the testing of fungicides for control of Mouldy Rot.

I. Root-Disease Investigations (Mr. Napper).

As in the previous year, field experiments on the control of root disease in connection with replanting formed the main research activity under this heading.

Regular rounds of tree-to-tree collar inspection and treatment were continued in the experiments established in earlier years, and one additional experiment was commenced which is described below under the reference number G.1.

Some of the more interesting results obtained are summarized in Tables I to IV, which are briefly commented on below. The presentation of full data must await separate publication.

TABLE I.

Experiment B.K.1. Incidence of root-disease infection up to the end of the third year after planting. Data arranged to compare the incidence under the different treatments.

Treatments.	Fomes lignosus.			Ganoderma pseudoferreum.			Fomes noxius.			Unidentified parasites.			Totals.		
	R.	B.	T.	R.	B.	T.	R.	B.	T.	R.	B.	T.	R.	B.	T.
A	45	14	59	35	39	74	8	25	33	5	6	11	93	84	177
B	72	26	98	44	71	115	7	40	47	8	17	25	131	154	285
C	99	31	130	19	56	75	10	44	54	4	25	29	132	156	288
D	131	30	161	22	42	64	11	38	49	1	10	11	165	120	285
E	129	42	171	27	44	71	8	38	46	3	15	18	167	139	306
F	78	28	106	36	112	148	6	34	40	1	5	6	121	179	300
Totals	554	171	725	183	364	547	50	219	269	22	78	100	809	832	1,641

R. = Nos. of infected rubber trees (including both dead and partially infected trees).

B. = Nos. of groups of bushes killed by root disease, excluding those associated with infected rubber trees.

T. = R + B.

For details of treatments *see Annual Report* of The Rubber Research Institute for 1937, p. 131.

EXPERIMENT B.K.1 (INLAND DISTRICT)—

For details of the treatments and lay-out of this experiment reference should be made to pp. 131-132 of Annual Report for 1937. Briefly, the treatments are as follows :

A. Digging to 18 inches throughout and removal of all roots.

B. Same as A, but dug to only 10 inches.

C. Disease patches dug deep enough to remove all infected roots. Remainder dug to 10 inches without collecting roots.

D. Disease patches dug as in C, but remainder not dug. Larger roots of healthy trees removed by felling with jack or grubber. (This is the present standard treatment).

E. No systematic digging. Diseased trees eradicated individually, and all infected roots followed up and removed. Healthy trees as in D.

F. No digging or stump-removal. All trees cut off at ground level and stumps injected with sodium arsenite.

The experimental area was exceptionally heavily infected with root disease before replanting, the main parasite in the old stand being *Ganoderma pseudoferreum*.

Table I shows the incidence of infection on the new stand up to the end of 1940 (i.e., to the end of the third year after replanting).

The most important data in this table are the incidence figures for *Ganoderma pseudoferreum* and *Fomes lignosus* (see *Annual Report* for 1938, p. 119). The former measure the success of the different treatments in dealing with areas infected with root disease in the original stand ; the latter measure their success in preventing subsequent outbreaks in areas carrying healthy trees at the time of felling. For convenience in discussion these two control problems will be referred to as (a) and (b) respectively.

Considering first the incidence figures for *Ganoderma pseudoferreum*, it will be observed that the numbers of infections under the different treatments up to the end of the period under review varied inversely in proportion to the amount of digging and eradication work carried out in the old root-disease patches before planting. Incidence of infection was lowest in treatments A, C, D and E where eradication was thorough, highest in treatment F where there was no eradication at all, and intermediate in treatment B where eradication was partial only. There can be little doubt therefore of the value of eradication in dealing with problem (a).

From the economic point of view the differences between the treatments were even greater than is indicated by the incidence figures. Data not published in the present report show that the cost of controlling *Ganoderma pseudoferreum* during the post-planting period was 4 times as high in F, and $2\frac{1}{2}$ times as high in B, as the cost of similar work in A, C, D and E. These greater differences in cost were due to higher *costs per point treated* in areas where pre-planting eradication was incomplete. With regard to treatments A, C, D and E in which the costs of post-planting control of *Ganoderma pseudoferreum* have been roughly equal, it should be pointed out that the costs of pre-planting control were widely different (*see* Table II). When total cost is considered treatment E is seen to be by far the most economical of these methods.

The high incidence of *Ganoderma pseudoferreum* in treatment F shows that poisoning infected trees is not a satisfactory substitute for eradication by digging as a means of dealing with problem (a). This is

TABLE II.

Experiment B.K.1. Costs of treatments per round and per year to the end of the third year after planting (in dollars per acre, excluding cost of supervision).

Year.	Round.	Treatment. A		B		C		D		E		F		Means.	
1st	1st	1.45		3.98		2.46		3.65		2.99		9.08		3.93	
2nd	2nd	2.65		5.84		4.00		7.95		4.67		10.90		6.00	
	3rd	1.69	6.40	1.87	11.71	3.41	10.71	2.38	15.00	3.92	12.86	6.38	25.27	3.27	13.66
	4th	2.06		3.99		3.30		4.67		4.28		7.99		4.38	
3rd	5th	2.19		3.06		2.18		1.95		2.78		3.79		2.66	
	6th	2.06	6.06	2.76	9.53	3.96	7.59	3.70	7.89	2.93	7.67	3.58	11.35	3.17	8.35
	7th	1.81		3.71		1.46		2.24		1.97		3.98		2.53	
Totals since planting		13.92		25.21		20.76		26.53		23.52		45.69		25.94	
Preparation (i.e., before planting) ..		71.86		41.18		50.79		44.54		25.11		10.28		40.63	
Grand totals		85.77		66.40		71.55		71.07		48.63		55.97		66.57	

For details of treatments *see Annual Report* of The Rubber Research Institute for 1937, p. 131.

readily understood when it is remembered that diseased roots quickly lose their internal structure, and cease to have any physiological contact with their parent trees. The fact needs stressing however in view of the firmly rooted popular belief that poisoning an infected tree will also poison the fungus in its infected roots. Poisoning, by killing the neighbouring living tissues, can prevent further spread of infection in the poisoned tree, but the infected roots are not touched by the poison, and remain sources of infection to other trees until they have rotted away, or have been removed by digging.

With regard to the incidence of *Fomes lignosus*, the figures for this parasite will be observed to vary inversely with the amount of digging and root extraction carried out in the *healthy* areas of the old stand before planting, being highest in treatments D and E (stump removal without digging), lowest in treatment A (stump removal plus digging to 18 inches) and intermediate in B and C (stump removal plus digging to 9 inches).

It may therefore be inferred that pre-planting digging and root extraction in healthy areas is a successful method of dealing with problem (b). The amount of digging justified from an economic point of view may be judged by reference to Table II. Deep digging as in treatment A can be ruled out on the ground of expense, leaving a choice between stump removal without digging, and stump removal plus digging to 9 inches (i.e., shallow digging). Comparison between the costs of treatments C and D shows that these two methods have been equally successful in the present experiment. C was more expensive initially on account of the additional digging in healthy areas, but higher incidence and cost of *Fomes lignosus* control during the first two years after planting brought the cost of D up to the level of C by the end of the second year, since when the costs of these two treatments have remained equal. It should be added that in general treatment D (which is the normal method of clearing healthy areas) is to be preferred to treatment C, for extensive digging is risky except on level ground, and in areas with a normal (i.e., lower) incidence of root-disease infection the extra cost of digging is unlikely to be repaid.

The low incidence figure for *Fomes lignosus* under treatment F is of considerable practical interest. It indicates that, as a method of controlling problem (b), poisoning is more successful than normal felling without digging (treatments D and E), and at least as successful as normal felling plus digging to 9 inches (treatments B and C). When costs figures are considered, however, treatment F loses some of its attractiveness. Owing to the presence of the old stumps, the *cost per point treated* in F has been over 50 per cent. higher than the cost per point treated in D and E. From the point of view of root-disease control poisoning has therefore shown no economic advantage over normal felling in the present experiment. Moreover, in view of the higher cost per point treated, the method is seen to be rather risky to adopt in any area liable to a heavy attack of *Fomes lignosus* after replanting. Poisoning does, however, reduce the *cost of felling*, and for this reason may be regarded as the cheapest method of clearing in areas where the incidence of *Fomes lignosus* after replanting is known to be low.

The final criterion by which the treatments must be judged is the *total* cost of root-disease control since the commencement of the experiment. These figures are given in Table II and show that up to the end of the period under review the most successful treatment, without question, was treatment E. Treatment F was cheaper initially, but its cost at

TABLE III.

Experiment B.K.1. Incidence of infection and comparative costs (in dollars) of root-disease control in creeping-cover and bush-cover areas since planting (excluding cost of supervision).

Round.	Creeping-cover areas (rubber trees only).		Bush-cover Areas.				Total cost in bush-cover areas.	Cost of inspection.	Total cost.	Cost per acre.
			Rubber trees.		Bush-groups.					
	Incidence.	Cost.	Incidence.	Cost.	Incidence.	Cost.				
1st	73	92.03*	56	60.69*	224	137.75*	198.44*	24.30	314.77	3.93
2nd	105	196.91*	74	119.31*	168	134.25	253.56*	29.70	480.17	6.00
3rd	66	92.70	53	55.13	103	89.33	144.46	24.74	261.90	3.27
4th	59	131.25	47	89.50	99	100.25	189.75	29.50	350.50	4.38
5th	51	75.25	51	73.25	37	31.00	104.25	33.00	212.50	2.66
6th	46	55.31	52	70.15	162	95.24	165.39	32.52	253.22	3.17
7th	46	86.65	30	39.65	39	37.55	77.20	38.25	202.10	2.53
Total incidence ..	446		363		832					
Total cost		730.10		507.68		625.37	1133.05	212.01	2075.16	
Cost per acre ..		9.13		6.35		7.82	14.16	2.65		25.94

* These figures are careful estimates based on the total cost of the respective round, and the proportionate costs per point treated at subsequent rounds.

the end of the third year was 10 per cent. higher than that of E, and was still rising more steeply than the cost of any other treatment. The rate of increase of cost in E was approximately the same as in A, B, C and D. There is little doubt therefore that its present economic advantage will be maintained.

Table III shows the incidence of infection and cost of treatment under bush covers and creeping covers respectively.

Considering rubber trees alone, both incidence and cost have been lower in the bush-cover than in the creeping-cover areas. This advantage in favour of the bush covers has been heavily outweighed, however, by the high incidence and cost of treatment *among the bushes*. The total cost of control in the bush-cover areas has been 55 per cent. higher than in the creeping-cover areas, and the former in addition have cost some $5 - per acre per year more than the latter to weed and upkeep. The total cost in the bush-cover areas has therefore been about 200 per cent. above the cost in the creeping-cover areas. This evidence tends to show that the planting of a leguminous bush cover expressly for the purpose of assisting in the detection and control of root disease is an uneconomic policy.

Experiment H.1. (Coastal District)*—

For a description of the purpose and lay-out of this experiment reference should be made to Annual Report for 1937, pp. 132-134.

Three further rounds of treatment were carried out during the year under review. The incidence of infection dropped to half the figure for 1939, but the disease cases were distributed between the treatments in roughly the same proportion as in previous years.

There is nothing further to add here to the comments made on this experiment in Annual Report for 1939, pp. 167-170. Treatment D (i.e., standard eradication in the old root-disease patches, plus normal felling without digging in healthy areas) is undoubtedly the most economical of the four methods compared in this experiment.

Experiment H.2. (Coastal District)—

A preliminary account of this experiment was given in the *Annual Report* for 1938, pp. 122-123, to which reference should be made for details of treatments. These are briefly summarised in Table IV of this report.

Root-disease control since planting has been carried out along standard lines. The first round of collar inspection and treatment was put through at the end of 1939, and three further rounds followed in 1940. Apart from a few cases of *Fomes noxius*, root disease in this area (as is the case on most coastal soils) has been caused exclusively by *Fomes lignosus*. Incidence and costs figures up to the end of 1940 are given in Table IV. Costs figures are expressed in "coolie-days" to eliminate the effects of fluctuations in wages.

Comparing first the clearing treatments A, B, C and D, it is of interest to note that incidence and costs figures for D are consistently double those for A, while the figures for B and C are approximately equal and lie midway between. There can be little doubt therefore that both ring-barking and poisoning have significantly retarded the development of *Fomes lignosus* in the old stumps. At present ring-barking appears to be superior to poisoning, but it cannot yet be predicted whether this superiority will be maintained. The two different methods of poisoning have so far been equally effective.

* In connection with this experiment attention is drawn to a misprint in the Annual Report for 1938, page 121; in the heading of Table II the Expermient reference should be H.1., *not* H.2.

TABLE IV.

Experiment H.2. Incidence of infection and cost of treatment (expressed in man-days) up to the end of the second year after planting.

Treatments.	Incidence of Infection.				Cost of Treatment (in coolie-days).		
	Rubber trees.	Leguminous bushes.	Totals.	Old stumps removed.	Rubber trees.	Leguminous bushes.	Totals.
A Frill-girdling without poison	35	5	40	39	247.0	18	265.0
B Frill-girdling with poison	51	7	58	56	334.5	51.5	386.0
C Stump-poisoning ..	52	8	60	52	399.5	45	444.5
D No treatment ..	68	9	77	69	498.0	35	533.0
Totals ..	206	29	235	216	1479.0	149.5	1628.5
1. Creeping covers ..	41	—	41	38	320.0	—	320.0
2. Bush covers	50	29	79	80	421.5	149.5	571.0
3. No covers	115	—	115	98	737.5	—	737.5

The incidence of infection has been moderate (under six trees per acre up to the end of the second year), but it will be observed that the cost per point treated is high, averaging about seven coolie-days per point. This is due to the fact that the root systems of the old trees were not disrupted during the process of clearing. At each disease centre the spread of infection is therefore considerable, and usually involves at least one of the old stumps, the removal of which is an expensive matter. Reference to Table IV shows that for 235 points treated it has been necessary to remove 216 stumps.

As in the case of inland soils, the high cost per point treated makes it risky to employ such methods of clearing except in areas where the activity of *Fomes lignosus* is known to be low.

With regard to the effects of the cover treatments 1, 2 and 3, it will be observed that the incidence of infection on the rubber trees in 3 (clean-weeding) was $2\frac{1}{2}$ times as high as in 1 and 2 (creeping legumes and bush legumes respectively) where the numbers of infections were roughly equal. This is in agreement with previous experience, for the presence of a ground cover has always been found to reduce the incidence of root-disease infection on the stand of rubber trees among which it is planted.

It will also be observed that although treatments 1 and 2 have been equally successful in reducing the incidence of infection on the rubber trees, treatment 2 is at an economic disadvantage because of the additional cost of treatment among the bushes. The total cost of root-disease control in treatment 2 since planting has been 80 per cent. higher than in treatment 1, without including additional costs of weeding and upkeep. This supports the evidence obtained in experiment B.K. 1 on inland soils, that the use of leguminous bushes for the express purpose of assisting in the detection and control of root disease is an uneconomic policy.

In order to investigate the effects of the different treatments on the rate of death of the old stumps, a round of stump inspection was carried out in January 1940 (i.e. at 15-18 months after the commencement of the experiment). Each stump was sampled by digging two pits, one on the east and one on the west side of the stump, and recording the condition of the roots exposed. Each pit was one foot square and 12-15 inches deep, and was placed at a distance of 3 feet from the stump.

The data obtained were examined by the Statistician, who reported that the effects of the poisoning treatments in hastening the death of the stumps had been highly significant. Ring-barking also had induced significantly quicker dying than pollarding alone. Using as a criterion of the condition of the stumps the percentage of stumps per plot showing live roots in one or other of the inspection pits, the average figures obtained were as follows :

Treatments	A	B	C	D
Per cent. of stumps showing live roots in either inspection pit	47.2	5.4	8.0	71.9

The lower lethal effect of A as compared with B and C is of interest in view of the fact that A appears, from the data of Table IV, to be more efficient than B or C in preventing the spread of root disease after felling. More data are necessary before an opinion can be expressed on this apparent contradiction.

Further analysis of the data showed that both non-poison treatments were significantly more lethal in the absence than in the presence of a ground cover (either creepers or bushes). Average figures were as follows :

Treatment	A		D	
	With cover	Without cover	With cover	Without cover
Per cent. of stumps showing live roots in either inspection pit	51.8	38.1	75.6	64.0

The additional lethal effect in the absence of covers is probably due to a greater degree of exposure to solar heat and desiccation. It is likely that a similar effect would have been observed in treatments B and C had stump inspection been carried out earlier.

Experiment L.P.1. (Coastal District)—

Details of treatments and lay-out of this experiment were given in Annual Report for 1938, pp. 121-122. Four rounds of inspection and treatment had been carried out by the end of 1940, but as the experiment is a small one, and the incidence of infection low, the figures obtained up to that time were not extensive enough to justify discussion in the present report.

Experiment G.1. (Inland District)—

A new replanting experiment bearing this reference number was commenced during 1940 to obtain further information on the effects of tree-and stump-poisoning on the incidence of root disease on inland soils, and to compare the poisoning properties of sodium arsenite and sodium chlorate.

The area available was a laterite hill carrying a stand of rather poorly grown trees, where root-disease activity in the past had been low. This area was very suitable as the experiment was not concerned with investigating problem (a). The old stand was examined for root disease before the experiment began, and the few small infected areas found were dug over in the usual way.

The felling treatments were as follows :

A. Trees frill-girdled and poisoned with sodium arsenite ; later felled by pollarding near ground level, the stumps being left to rot *in situ*.

B. As A, but using sodium chlorate.

C. Trees felled by pollarding near ground level; stumps poisoned with sodium arsenite and left to rot *in situ*.

D. As C, but using sodium chlorate.

E. Normal felling (trees felled by cutting through the roots below ground level, the stumps being removed in the act of felling).

F. Trees felled by pollarding near ground level ; stumps not poisoned, but left to rot *in situ*.

The lay-out is a 6 × 6 latin square with one-acre plots, the total area being 36 acres.

Treatment was commenced at the end of April and by the end of May everything was completed except the felling of the trees in treatments A and B, which was deferred until September, i.e. until just before planting.

The effect of sodium arsenite in treatment A was rapid and striking. Browning of the leaves was well in evidence 10 days after treatment, and at the end of a month defoliation was practically complete. The average amount of sodium arsenite used per tree was only $\frac{1}{4}$ lb., but it must be remembered that the trees were below the average in size, and stood in a dry situation where the effects of poisoning are liable to show up best.

The effect of sodium chlorate was less conspicuous. It was barely visible in the foliage of the B plots even at the time of felling, i.e., four months after treatment. At that time, however, a progressive dying back of the cambium of the boles and roots below the level of the frill-girdle had become generally noticeable in treatment B, though there was still little sign of die-back in the latex-bearing tissues.

The progress of decay of the stumps and lateral root systems under the different treatments will be followed by means of the stump-sampling technique employed in Experiment H. 2 (see above).

Approximate costs of the different types of treatment (including felling costs) were as follows:

Pollarding after poisoning by frill-girdling (treatments A and B)	$12.50	per acre
Pollarding and stump poisoning (treatments C and D)	20.00	,,
Pollarding without poisoning (treatment F) ..	15.50	,,
Normal felling (treatment E)	28.50	,,

The general low level of these costs figures is due to the fact that the trees were well below normal size. Even so, considerable economy was effected by employing poisoning methods in place of normal felling.

It will be noted that treatments A and B were cheaper than treatment F. This was due partly to the smallness of the trees which, having already been frill-girdled, needed little extra cutting at the time of felling, and partly to the fact that, being small, they died quickly, and their leafless and partly decayed crowns were much easier to deal with at the time of felling than the crowns of unpoisoned pollarded trees. Large trees die less quickly, and are sometimes more difficult to fell when poisoned owing to the drying and hardening of the tissues of the poisoned trunks. In general, therefore, treatment of the type used in A and B may be expected to be more expensive than treatment F, especially at war-time prices for sodium arsenite.

Practical Recommendations—

New information obtained in the course of the experiments described above, has made it necessary to modify practical recommendations for root-disease control in connection with replanting.

With regard to the control of problem (a), the favourable results of treatment E in Experiment B.K. 1 shows that it is unnecessary to dig over the open central areas of the old root-disease patches. The superiority of treatment E over treatment F shows that the diseased roots of known infected trees should be removed by digging, but further digging appears to be uneconomic (except to remove additional sources of infection discovered in the course of felling or holing). This may now be accepted as a general recommendation both on inland and coastal soils. It should be added that where root-disease patches are being cleaned up in mature areas which are *not* to be replanted for some considerable time, greater care must be taken over the eradication of infected roots. If the patches are to be supplied the centres need not be dug over, but annular zones at least 25 feet wide must be carefully cleaned up around the margins if reinfection of the surrounding mature trees is to be avoided. Small patches which are not to be supplied should be completely dug over.

With regard to the control of problem (b), poisoning by either the frill-girdling or stump-poisoning technique appears to be a cheap and successful method of clearing healthy trees, which can safely be recommended in any area where the incidence of *Fomes lignosus* after replanting is known to be low. It is especially suitable for use on steeply sloping ground, where soil disturbance must be reduced to a minimum. Care should be exercised, however, in using the method in any area where the activity of *Fomes lignosus* after replanting is likely to be high. This warning applies particularly to coastal soils. In doubtful cases normal felling is the best alternative.

The choice between poisoning by frill-girdling and stump-poisoning depends on circumstances. The latter is a little cheaper, but has the disadvantage that it must be carried out 3 months at least before felling, with consequent loss of crop.

The cheapest clearing method of all is to poison by frill-girdling and allow the poisoned trees to decay *in situ*. In this way felling is entirely avoided, and the old trees can be tapped right up to the time of planting, and even later if so desired. The crowns of the trees rot and fall down piecemeal and the damage caused to the young stand is surprisingly small, but the method carries a risk to human life which cannot be disregarded. The method has not been included in any of the replanting experiments described above as such experiments have to be carried out on outside estates where we cannot be expected to accept responsibility for this risk. It has been tested, however, at the Experiment Station as a method of clearing jungle trees for new planting [see *Annual Report* for 1939 (Botanical Division) p. 147].

Key to locality of experimental centres referred to by index letters in the text.

B.K. = Batang Kali Estate, Ulu Yam, Selangor (Anglo Malay Rubber Co., Ltd.).

H. = Highlands Estate, Klang, Selangor (Highlands & Lowlands Para Rubber Co., Ltd.).

L.P. = Lower Perak Estate, Teluk Anson, Perak (Lower Perak Rubber Estates Ltd.).

G. 1 = Ledang Estate, Tangkah, Johore (Ledang Bahru, Limited).

II. Above-Ground Diseases (Mr. Beeley).

Diseases of the Tapping Panel.

Mouldy Rot (*Ceratostomella fimbriata*)—

Absence on long leave prevented any further work on this disease being carried out.

Testing of Fungicides—

Though the early part of the year was very dry, the last four months were very wet with the result that the rubber trees in our fungicide-testing area became 100 per cent. infected with Mouldy Rot. Some six preparations, two oily pastes and four white fluids, were put through the various tests. Two white fluids were passed as suitable for control of Mouldy Rot and the remaining four were deemed for various reasons unsuitable.

The two fungicides which passed the tests are known as Paragerm, which is commonly used in the N.E.I. for similar purposes, and "Ialine" Ordinary Disinfectant.

Black Stripe and Patch Canker—

The wet weather towards the end of the year was responsible for a number of enquiries reaching us on the subject of Phytophthora diseases of rubber trees. Buddings with heavy foliage are usually the victims of attack. As a rule normal treatment with a white fluid fungicide will keep the disease in check but on some occasions it has been found that thin films of coagulum covering areas several inches in diameter have formed beneath the bark of the tapped panel which may not be discovered until cracks appear and the latex pad begins to putrefy resulting in death of considerable areas of the renewing bark. Since the black lines typical of this disease are seen only with difficulty in the patches of dark grey sunken bark, the occurrence of such patches should be reported by the tapping coolies and early treatment given.

Further cases of Phytophthora attack of young bud shoots and seedling rubber have been investigated during the year.

Sunscorch of the Tapping Panel—

The continued dry weather in the early and middle part of the year resulted in further cases of this form of damage being brought to our notice. Experiments are now in progress to determine the effect of palm oil on the tapping panel during the drier seasons of the year. It is hoped that the coating of oil will prevent excessive drying out of the inner cortex exposed by the tapping process and promote a more rapid rate of renewal of bark.

Brown Bast—

An investigation of the occurrence of bacteria in the latex vessel system revealed that large numbers of bacteria inhabited the upper region of bark immediately below the tapping cut. The investigations were extended to include samples of bark from healthy trees and trees in various stages of Brown Bast, since it may be possible that

continued presence of active bacteria, even though not truly parasitic, in the latex system may cause sufficient irritation to the neighbouring cells to set up gum formation and meristematic activity.

It has been found that the discoloured bark beneath the cork layer in a tree which is still in tapping and has got Brown Bast contains more bacteria than is usually found in healthy tapped bark, while that of a Brown Bast tree which has been rested for several months contains few bacteria and in many cases was sterile. The effect of gummation and meristem activity appeared to account for the disappearance of bacteria from the bark of the rested trees.

Stem and Branch Diseases.

Pink Disease (*Corticium salmonicolor*)—

Early in the year this disease was of comparatively rare occurrence but the onset of rain in the later months caused some fairly extensive though local outbreaks in areas of young rubber close to the main watersheds. Frequent rounds of inspection and treatment are necessary during periods of heavy rain-fall if the disease is to be kept under control. One interesting modification of the normal treatment has been suggested and consists of the flaming of the infected branches by a low temperature smudge flame preparatory to carrying out pruning or application of fungicides. Knowing the attraction which scorched bark has for borers we are unable to recommend this method until its efficiency has been fully investigated.

Diseases of Buddings—

Early in the year a number of reports was received of spearhead dieback of the stem of young buddings just above the union. This appears to be due to hot dry weather conditions which caused a desiccation of tissue at the pruned surface of the stock which in turn robs the bark above of moisture ultimately causing it to die-back, so that a narrow strip of bark about an inch wide and several inches long is killed. Treatment consists in painting the stock and scion with white paint or limewash to reflect the sun's heat and promote callus growth.

Further occurrence of bark-bursts and of pads of coagulum forming between the bark and the wood have been reported. The disease appears to be of physiological origin and is in no way connected with similar symptoms caused by Patch Canker or Black Stripe on the tapping panel. See Annual Report for 1939, p. 173. Since that report was written it has been found that the presence of the latex pad may prevent complete healing by callus tissue so that below the outer raised portion of the bark the wound can be traced sometimes one or two inches into the wood according to the time lapsing since the burst was originally caused.

Clones in which bark-bursts occur though well grown are usually lacking in girth in the lower tapping panel region. They have prominent dormant buds with which the bark-bursts are often associated and are very responsive to wounding as a result of which an excessive callus development takes place. Control by application of bark and tapping stimulants is under investigation.

Leaf Diseases.

Hevea Leaf Mildew (*Oidium Heveae* Steinmann)—

During the early months of 1940, Malaya was fortunate in having weather which is considered practically ideal for the purpose of the wintering and refoliation of rubber trees. The wet weather at the end of 1939 and in early January, 1940, was not so heavy as to prevent the normal changing of colour of the old leaves, while in February and March the dry weather induced a shedding of old leaf and growth of new leaf so rapidly that by the end of March most trees, especially in the northern States, had obtained a complete new canopy of foliage without any sign of leaf mildew. In April again the weather though occasionally wet was never of the dull, over-cast type with the result that the central and southern States were able to obtain a complete refoliation with only an occasional infection of Oidium. Indeed it was the absence of dull cool showery weather rather than the actual amount of rainfall which minimised the effect of the leaf mildew during the 1940 refoliation season.

A table showing the rainfall for the same six districts as given in previous years' reports shows the rainfall in all districts except Kuala Lumpur to be lower than in previous years.

Table I.

Rainfall in Inches.

Districts.	Jan.	Feb.	Mar.	April.	May.	Total for five months.
Kuala Lumpur (Sel.)	5.80	5.98	12.04	9.61	11.76	45.19
Sitiawan (Pk.)	2.94	5.64	4.07	9.94	5.01	27.60
Port Dickson (N.S.)	2.29	1.92	1.33	6.35	7.73	19.62
Tampin (N.S.)	2.17	0.78	3.60	8.89	4.08	19.52
Malacca (S.S.)	0.64	1.43	1.68	1.29	8.68	13.72
Johore Bharu (J.)	2.37	6.02	1.71	6.06	9.26	25.42

It is significant that only 31 estates reported outbreaks of Oidium during the 1940 season. As a consequence it was thought unnecessary to publish a full report as in previous years.

Minor Leaf Diseases—

There is no appreciable change in the position under this heading from that reported last year. There seems still to be some need for investigating the effect of minor elements on the vigour of leaves of certain clones which appear to be continually ravaged by mites and leaf-spot fungi, since the pest and fungi cannot singly or severally be considered primary parasites. The Botanical Division is investigating the effects of mineral deficiency with a view to elucidating this problem.

In very young plants however the causes leading to attack may be of temporary nature only and suitable dusting or spraying with fungicides or temporarily shading the young plants will often help to improve growth conditions considerably.

III. Insect and Animal Pests (Mr. FitzGerald).

Cockchafer Pest.

The Common Cockchafer of Rubber Cultivation (*Psilopholis vestita* Sharp)—

The distribution of *Psilopholis* in Malaya is extremely peculiar. As a pest the insect is confined to isolated centres towards the Western side of the Peninsula extending from Johore in the South to Kedah in the North. All centres of infestation are very similar in particulars of soil, topography and proximity to jungle. But sites of this nature are typical of a far larger number of estates than those at which the pest is found. Under these circumstances it is strange that apart from a tendency for the centres of highest grub-density to shift around a confined area from season to season, no lateral spread from centres of infestation has been observed although these centres are themselves attacked year after year. Sample pits have been dug in primary forest alongside infested rubber estates as well as far inside blocks of virgin forest. Among several hundreds of grubs obtained during these surveys not a single *Psilopholis* has turned up.

Psilopholis is more a pest of the plantation than of the *plant*. Fields of immature rubber are not attacked and it is unusual that a mature tree is attacked severely enough to be harmed. In the aggregate, however, there is evidence that the yields from trees growing in infested areas are reduced as a direct result of root destruction by cockchafer grubs. The main damage for which *Psilopholis* is responsible is damage to the fertility of the soil. Destruction of cover, loosening of soil and penetration of bunds are all factors accelerating soil wash which becomes especially serious on hill sides. The persistent attack which takes place in infested areas brings about impoverishment of the land and exposure of lateral roots. The indirect loss in crop under these circumstances is reported by planters who have experienced cockchafer attack as being serious.

The life cycle is completed in one year and this insect is highly seasonal in its development. The eggs are laid in clusters in the soil during February and March and the grubs hatch out after about a fortnight. No food preference by the grubs have been discovered. Both living and dead roots of any plant which was offered have been eaten indiscriminately. Besides this, other vegetable matter and a quantity of soil is also passed through the body. The habits of the adult beetle are not yet fully understood but it is probable that the key to the distribution of this insect and very possibly a reliable method of control will become apparent when its requirements during this stage are known. Contrary to what has been reported previously, it appears to be absolutely essential that the adult *Psilopholis* should visit forest trees for the purpose of feeding prior to oviposition.

Outbreaks of *Leucopholis-Lepidiota*—

The larvae of these species are large grubs bearing a close superficial resemblance to *Psilopholis*. It is probable that they have been confused in the past, nevertheless the whole aspect of the problem that they present is completely different. The life histories of the various species have not yet been fully elucidated. They are found throughout the country. Cockchafer reports from the East coast districts, upon investigation, are found to be caused by these species

and not *Psilopholis*. In Kedah these cockchafers are as harmful as *Psilopholis*. Whereas *Psilopholis* occurs in sedentary granite soils, the species of *Leucopholis* and *Lepidiota* are found in transported silty soils. *Psilopholis* is confined to mature rubber adjacent to primary forest but these other species originate in secondary forest and possibly grass lands.

Damage by these species may be direct, i.e., if secondary forest or old cultivation is planted with rubber the grubs existing in the soil will destroy the young plants which they find. Under certain circumstances it also appears that these pests may persist in areas of rubber trees and bring about the same soil deterioration under mature trees as has been noted for *Psilopholis*. Except at estates in Kedah, which have not been visited very frequently, the present species appear to be kept in check by natural means. Temporary remedies which become necessary in new plantings are discussed below.

Cockchafers of Secondary Forest—

Under the present heading are included a large assemblage of species occurring in secondary forest in which small trees of the genus *Macaranga* are abundant. The life histories of all species encountered are being worked out but from a practical point of view the species of *Lachnosterna* and *Exopholis* appear to be most important.

Unlike the above-mentioned species of *Leucopholis* and *Lepidiota*, the cockchafers in the present group return to feed as adults upon the leaves of trees prior to oviposition. This fact limits their distribution to secondary forest ; they do not persist in pure rubber plantations and the damage they cause is confined to young newly-planted trees. The damage consists of direct attack upon seedlings and basket plants by the grubs left over in the soil after the secondary forest is felled. Direct application of soil larvicides to the whole area is limited by considerations of cost. A more promising line appears to be the protection of the plants by repellents during the period that the grubs remain active in the soil prior to pupation.

Artificial Control of Cockchafers in Rubber Plantations—

Chemical Control by Soil Injection.

The availability and cost of materials are of primary importance. The efficiency and cost of application are of hardly less moment. The above considerations combined decide if the treatment can be administered economically. The object of treatment is clearly to eliminate damage, and in the case of *Psilopholis* this can be achieved by quite a moderate reduction in the grub population provided this can be brought about sufficiently early in the season. Complete destruction of all the larvae is not required except in the case of an initial infestation of restricted extent in a new area. The question as to what percentage of a generation must be destroyed in order to cause an adequate reduction in the numbers of subsequent generations is not yet answered. But grub mortality, other things being equal, is very largely proportional to the rate of application of the larvicide.

Carbon bisulphide is undoubtedly the most efficient soil fumigant known and its use, both pure and in emulsions, gives satisfactory results. It was first used as a soil fumigant as long ago as 1883. It has the general disadvantage of being highly inflammable and, mixed with air, violently explosive. Locally it is highly priced owing to the necessity of importing it from abroad and to the restrictions on carrying and handling it by shipping companies. Temporarily it is quite unobtainable. Present investigations on the use of carbon bisulphide have been directed towards (a) a ready and cheap source of supply ; (b) an efficient and economic method of application ; and (c) a suitable diluent to use in emulsions which should be cheap and able to reduce the harmful effect of carbon bisulphide on living plants. The cost of material can be somewhat reduced by employing the carbon bisulphide in the form of an emulsion. Owing to the limited supplies of carbon bisulphide available no emulsion could be tried out this season. The following have however been used with varying degrees of success against cockchafers by other workers :— (a) CS_2 emulsified in water with rosin fish-oil soap ; (b) CS_2—trichlorethylene ; (c) CS_2—wormseed oil ; (d) CS_2 emulsified in water with Agral. Some of these have already been tried in Malaya and while they have in general been found effective they have the same limitations from a practical point of view as pure carbon bisulphide.

Carbon tetrachloride has been under trial here for some years but shows little promise. Methallyl chloride has been found a promising substitute for carbon bisulphide in Malaya. Its cost, however, is prohibitive. Potassium sulphocarbonate has shown up very badly in trials this year and in view of the high cost of this substance it is not likely to be experimented with further. Petrol and similar oils have been suggested at various times but the reports of the results obtained are very conflicting. Under local conditions petrol has the great advantage of being (normally) readily obtainable and when used freely a satisfactory kill has been obtained. The effective rate of application, however, reaches 172 gallons per acre and so the cost is prohibitive under present circumstances.

Chemical Control by Use of Repellents.

Repellents for use in the protection of seedlings and basket plants show considerable promise. Naphthalene and paradichlorbenzene are reported on under the section of this report dealing with termites. Their extensive trial against cockchafers has not been possible owing to the impossibility of obtaining a sufficient quantity of these substances at the present time.

Coptotermes, the " White Ant " Pest of Rubber.

The " white ant " problem is complex and though considerable progress has been made with the treatment of attacked trees the biology and ecology of the pest are still very imperfectly understood. Until these fundamental points have been studied permanent control of the pest is not possible. Several species are present in rubber plantations and although these are very similar to each other important difference in their habits are coming to light. Previous workers did not appreciate these distinctions, so some of the information they obtained loses its value.

Control methods for white ants may be summarised as follows:

(1) Ecological, that is by attention to the surroundings. This consists of the discovery and destruction of nests and the removal of stumps and logs harbouring "white ants". It is useless to destroy the easily-obtained queens of the wrong kind of termite and it also seems probable that the *Coptotermes* which attacks living trees is not the same as the *Coptotermes* usually found in dead wood. Therefore great care is necessary and as this method is very expensive further study is required before it can be recommended.

(2) Treatment of attacked trees with an insecticide. This method has been very fully dealt with in the *Annual Report*, 1939. Using mercury perchloride successful control can be obtained but the method has two disadvantages. First the poison does not reach the nest so there is a strong tendency for fresh trees to become infested. Secondly in cases of subterranean attack the plant is often beyond help before the attack becomes apparent.

(3) Treatment of all trees with a repellent. In order to overcome the difficulty of driving the termites from tree to tree, and also to obviate the necessity for waiting until signs of damage become apparent, the application of repellent substances is being tried. An ideal repellent should be effective against the pest; harmless to the tree; durable in the soil; cheap to buy and easy to obtain. It might even be possible to combine an insecticide and repellent and it is thought that such treatment would prove very useful in new plantings both against termites and cockchafer grubs. Trials of suitable material have been held up by the difficulties of getting the necessary chemicals. Both naphthalene and paradichlorbenzene have been found promising. Experiments designed to ascertain suitable dosages, the effect on plant growth, and durability in the soil are in progress, but it has not yet been possible to test the direct insecticidal or repellent value of these chemicals against either termites or cockchafer grubs in the field.

Other Insect and Animal Pests.

Rodent Damage—

A variety of types of damage to seedlings, buddings and immature rubber generally have been attributed to "Rats". In many cases it is very difficult to decide for certain what exactly is responsible for damage of this nature, but it seems at least probable that rats as generally understood, i.e. *Rattus rattus*, are only responsible for a very small amount of the damage experienced on rubber estates. Squirrels of various species are, on the other hand, responsible for considerable damage especially to areas adjacent to some sort of cover such as the jungle edge; a stream ravine full of secondary growth; a large clump of bamboo or even inter-row accumulations of timber and brushwood. A rat population may be very numerous but individually they may cause very little damage or only a limited number of the individuals may adopt a harmful method of feeding. A squirrel population on the other hand may be quite limited but one individual may cause considerable damage. For these reasons it is important to diagnose the culprit correctly because such methods of control as hunting, shooting or poisoning, while likely to be somewhat disappointing when employed against rats, will usually produce the desired result if squirrels are responsible for the damage. In

order to aid the planter in diagnosing the cause of the various types of damage which he may notice, a brief résumé of typical examples is given below.

Rubber seeds are a favourite food of squirrels of several species. These animals are in the habit of visiting rubber plantations in order to feed on the fallen seeds during the seeding season. A squirrel searches for the seed on the ground and then runs away with it and usually goes a short way up a trunk to consume it. Now, so long as seeds shed by mature trees are abundant these are likely to provide the chief attraction to squirrels and feeding on them will not cause any harm. But at other times a group of seeds planted at stake or in a nursery bed may be raided and carried off by the squirrel. If the seeds have started to germinate the shoot will be torn off and left on the spot while the seed is carried off. In the case of rats being responsible for seed destruction, since these animals usually consume the seed on the spot, fragments of the seed's coat will be noticed at the place of damage. Similar fragments, if squirrels are responsible for the damage, will be found only at the bases of neighbouring trees or other convenient feeding spots.

Various forms of damage to germinating seedlings which do not involve the removal of the seed, cannot be attributed to either rats or squirrels with certainty. A common form of damage consists in the nipping off of the shoot tip before the young leaves have been able to expand. This type of damage is thought to be due to grasshoppers. When the seedling begins to wilt as a result of this form of attack the giant snail may sometimes be found feeding on the plant. There is however no evidence that the snail ever attacks a healthy seedling.

When the seedling has reached a foot or eighteen inches in height and the lower part of the stem has become woody another type of damage is often noted. In this case the stem is cut ; sometimes it is completely severed ; at other times it is partly cut through and a strip of bark, detached at the lower end but still attached at the upper end, may be noticed. If plants damaged in this way are examined carefully it will be found that the pith in the centre of the stem has been removed. It is almost certain that squirrels are also responsible for this type of damage although rats cannot be entirely exonerated.

When the plants have become much older and have formed a strong pole-like stem the bark will sometimes be found to be cut spirally round the stem to a sufficient depth to cause a considerable flow of latex. It is usual when this type of damage occurs for several trees to be attacked within a restricted area. Squirrels are entirely responsible for this type of damage. Upon more than one occasion woodpeckers have been incriminated but apart from the fact that these birds could not possibly cause spiral cuts of the nature described, it seems fairly certain that they only visit trees already damaged in this way for the purpose of eating any small insects which may be visiting the original wounds or which may have become stuck in the latex. On larger trunks and tapping panels a similar type of wounding is also occasionally caused by squirrels. In this case the wound is more of the nature of a squarish patch rather than a spiral cut.

Before closing this brief survey of the different types of damage it is worth noting that when green shoots are broken off monkeys should be suspected. If they appear to have been nibbled off then mouse deer may be the culprit.

There is no doubt that in the case of damage caused by squirrels, hunting is the most promising method of control. A watcher armed with a shot gun should be posted during the early morning and again during the evening. It is worthwhile noting that certain "tree shrews" with beneficial insectivorous habits are extremely like squirrels to look at but may be easily recognised by their pointed snouts. These should on no account be shot.

Other methods of control which have been tried are poisoning; scaring with Chinese crackers; guarding plants with paper, wire or wicker-work cylinders and repelling by smearing the stems of the plants, or sticks placed alongside the plants, with tanglefoot or a paste containing flour and barium carbonate.

Pests and Cover Plants—

A "Lady-bird" beetle, *Epilachna indica* Muls., up to 6.5 mm. long, dull red in colour with six large black spots on each wing case, is a very common pest of *Centrosema pubescens* causing considerable damage. *Pueraria javanica* is also attacked to a lesser extent. The "Brinjal" (*Solanum melongena*) is also a favourite food plant of this beetle. The eggs are pale yellow in colour; spindle shaped, about 1 mm. long; laid in clusters on the lower surface of the leaves of the food plant. The larva hatches four days after the egg is laid; it changes its skin three times before becoming full grown in rather less than three weeks. The larva is greenish-yellow coloured. The pupa is formed on the leaf of the food plant and the perfect insect emerges after three days.

Control measures necessitate spraying or dusting but it is very doubtful if either the extent of the damage or the value of the crop would ever warrant this type of treatment over large areas. There are a number of sprays and dusts designed for the control of closely related pests, such as the notorious Mexican bean beetles and others, which should prove of use against *Epilachna indica*. Amongst these the following formulae are worth trial:—

(1) Dust; one part lead or calcium arsenate and three parts lime or kaolin.

(2) Dust; Derris powder (0.5 rotenone) at 20-25 lb. per acre.

(3) Spray; 2-3 lb. Derris root in 100 gallons of water.

(4) Spray; magnesium or lead arsenate 2 lb. in 50 gallons of water.

Grasshoppers have been reported as causing damage at different times throughout the year. Several species have been received and among these the following appear to be the most important:

(1) *Valanga nigricornis*, a common large green grasshopper with red on the under wings. Specimens as long as 80 mm. may be encountered.

(2) *Catantops humulis* and *C. splendens*. Both of these are smaller, brownish grasshoppers with short antennae. The former averages about 30 mm. long and the swollen femur of the hind legs is conspicuously marked with two black bands. The latter is rather larger, 40 mm. long, and the hind femur is unbanded.

(3) *Mecopoda elongata*. This is a large, 75 mm. grasshopper with very long antennae. In colour specimens vary from brown to green.

Grasshoppers in general breed in open places such as mining land, railway embankments, etc., and from these localities they are liable to invade rubber plantations. But large blocks of *Pueraria javanica* are favourite breeding places. Large numbers of grasshoppers bred in the *Pueraria* may spread to other parts of the estate. Damage caused is spasmodic. Apparently little damage is caused to the cover crop under normal circumstances. But for short periods young rubber trees may be entirely defoliated by the adult grasshoppers. Germinating seed is very liable to be nipped off when quite young specially by the species of *Catantops*. The risk of this type of damage is increased if grasshoppers are breeding somewhere on or near to the estate. When treatment becomes necessary the first requirement is to discover where the grasshoppers are breeding. Breeding grounds may be known by the presence of "hoppers" i.e., flightless young grasshoppers. When the hoppors have been located it is here that treatment should be applied. The spreading of poison bait is the most promising way of controlling grasshoppers and the following formula is to be recommended: bran, or some other similar product obtainable locally, 25 lb., white arsenic, not more than $\frac{3}{4}$ lb. As the pellets of bait in this country are very liable to be dried up by the sun or washed away by rain it seems that the only way of applying the bait is to broadcast a little at frequent intervals about places where "hoppers" are known to be present. If young trees are attacked by flying adults a poison spray may be used or the adults may be hunted down by children armed with sticks and nets. Germinating seeds may be protected during the critical period of their growth by employing paper cylinders. As soon as the first green leaves have fully expanded the risk from grasshopper damage is negligible and so then the cylinders can be removed and any vacant points supplied with basket plants which have outgrown the critical stage.

Caterpillars—

During 1940 very few reports of damage by caterpillars have been received.

A most unusual outbreak of bagworms occurred on one estate where young rubber trees were being grown under the shade of *Albizzia mollucana*. The species concerned was probably *Clania variegata* Snell, which completely defoliated the *Albizzia* and then fell down on to the rubber which it also defoliated. The caterpillars were reluctant to feed on rubber leaves however and in most cases simply bit off the leaves and let them fall to the ground. The pest was entirely dependent on the *Albizzia* for breeding and showed no signs of spreading to rubber trees away from *Albizzia*.

"Cutworms", caterpillars of moths of the family *Noctuidae*, periodically become abundant for a short time on a variety of cover crops. An attack, while it lasts, is often quite spectacular but it is most unusual that the second generation of caterpillars comes to anything. Natural causes such as change in the weather, disease or the spread of parasites are usually sufficient to decimate the caterpillar hordes and the cover subsequently recovers. Spraying with any of the usual stomach poisons will hasten the dispersion of the caterpillars and subsequently the application of a fertiliser will hasten the recovery of the plant which has suffered.

"Pyralid caterpillars" are very small caterpillars which turn into small moths. The caterpillars feed on the leaves of a variety of cover crops within the shelter of a rolled leaf edge or between two or more leaves which have been spun together. The adults can be driven out by beating the plants, when a small moth will be seen to fly out and quickly come to rest again out of sight under a leaf. These caterpillars are more or less always present on most kinds of cover and although they frequently spoil the appearance of the crop, the damage they cause is seldom severe enough to warrant treatment. Upon rare occasions an outbreak may occur but, as in the case of the "cutworms" the normal balance is quickly restored by natural factors and no special treatment is called for.

It may be mentioned here that the appearance of any pest on a rubber estate should be reported to the Rubber Research Institute, as it is only by carefully recording the history of outbreaks that an opinion can be formed as to whether a pest is dangerous or not.

Eelworms—

There have been few reports of this pest during 1940. Of the various species of leguminous covers planted in a heavily-infested field at the Experiment Station, *Derris* sp. and *Abrus* sp. show some promise of being resistant to the effects of eelworms and form an effective ground cover during the early years of the plantation.

Giant Snail—

Meta fuel, which has hitherto been used and given satisfaction as a poison for the control of giant snails, is unobtainable at the present time. A search has therefore been commenced for a substitute and at the same time experiments designed to find out the relative attractiveness of various substances have been started. The biology of the giant snail is also receiving attention but it is premature at the present time to place on record any conclusions. In the meantime planters who experience damage from this pest must fall back on the old Calcium arsenate-Bran bait method which is described in the *Journal* of Rubber Research Institute, Vol. 8, No. 2, p. 133, 1938.

General—

Organisms affecting rubber cultivation may be classified as (1) direct pests of rubber and (2) pests of cover crops. The former may be sub-divided into pests of mature rubber and pests of immature rubber, and further subdivisions can be made to include the pests of leaves, stem, both internal and external, and roots.

An important section of the work is the study of "potential pests" since it is very possible that some insects, either indigenous or new arrivals, may some day acquire a taste for Hevea which is yet of comparatively recent origin and largely in an unimproved state. A survey of the beneficial insects found in rubber plantations is also in progress as a preliminary to a search for parasites which may be required for purposes of biological control of certain pests.

A collection of insects connected with rubber cultivation has been commenced and a record of all organisms received from estates or reported from rubber areas is filed in a card index.

A new insectary was built near the Institute where biological problems are being studied. Various field experiments have been undertaken at the R.R.I. Experiment Station where an entomological garden is being established.

In this connection acknowledgments are due to the officers of the Pathological Divisions of the Rubber Research Institute who have dealt with the entomological problems in former years and who have greatly helped the present year's work ; to the Entomologists of the Department of Agriculture, Straits Settlements and Federated Malay States, who have continued to give advice and have allowed free use to be made of their collections and library ; to the Director of the Selangor Museum for help in identifications ; and to the Imperial Institute of Entomology for general assistance.

IV. Bacteriology (Mr. Beeley).

Soil —

Work on the nodule organisms of leguminous cover crops commonly used in this country has followed three main lines. Firstly the preparation of cultures of Rhizobia for distribution to estates, secondly the isolation of new strains and the retesting of old or rejuvenated strains in mineral solution or pot cultures and thirdly observation and measurement of growth of rubber with and without covers in pot culture experiments.

The production of Rhizobia cultures for distribution to estates continued throughout the year and some 60 estates have been supplied with cultures to the total of 598 tubes comprising the following strains :

Centrosema pubescens ..	430	*Derris* sp.	2
Calopogonium sp. ..	5	*Desmodium triflorum* ..	2
Crotalaria sp. ..	2	*Pueraria* sp. ..	149
Vigna sp. ..	2	*Tephrosia* sp. ..	2
Desmodium ovalifolium	4		

Host plants of the above species are grown in pots of sterilised soil inoculated with the appropriate strain of organism in order to maintain the vigour of the culture, since it is suspected that old cultures after much subculturing may loose their nodule and N. assimilating properties to some extent. New and rejuvenated strains are then tested first in plants grown in test tubes with nutrient solution or a nutrient agar medium, and then with plants in pots containing sterilised sand-soil mixture.

Observations and measurements of growth in pot-culture experiments, which as stated in the *Annual Report*, 1939, p. 191, consist of trials with rubber trees in large pots (a) with legume and some non-legume covers, (b) without covers and (c) with and without nitrogenous manures. After 15 months' growth the following general observations may be recorded.

1. The best growth of Centrosema occurred in pots of sterilised sand-soil mixture inoculated with Rhizobia. The same cover in unsterilised soil even after several months was not so vigorous and green as the former.

2. Rubber trees in the confines of the 18-inch pots used in this experiment showed best growth in the pots receiving complete mineral fertilizer including nitrogen and without any ground cover, and the

worst growth in pots containing a vigorous growth of the Centrosema cover. Pots with grass and non-leguminous cover plants showed a medium growth of rubber trees.

3. Root competition with the cover plants appears to be a most important factor concerned in the early growth of rubber trees. In several pots the growth of the rubber was stunted in the first few months and then almost completely inhibited by a luxurious growth of *Centrosema pubescens* even though the cover plant was prevented from climbing on the rubber trees.

LATEX—

With the capable assistance of Mr. John analyses of the bacterial numbers in latex preserved in various ways have been made from time to time for the Chemical Division. References to this work will be found in the Annual Report of that Division.

In an endeavour to obtain workable quantities of clean sterile latex a tapping chamber was designed whereby the usual operation of tapping the tree and collecting the latex could be carried out under controlled conditions and without contamination from outside agencies. This chamber was firmly attached to the bole of the tree covering the tapping panel and when tested under pressure was shown to be reasonably air tight. The front of the chamber consisted of rubber-proofed cloth fitted with two celluloid windows below which a pair of rubber gloves was cemented into holes in the cloth. The lower wooden collar of the chamber was pierced by rubber bungs through which passed glass tubes leading to spray nozzles or other apparatus required within the chamber but manipulated from outside. Through the medium of these, various disinfecting agents were used, and the atmosphere within the chamber controlled as desired. The sterilised tapping knife remained in the chamber, while a zip fastener slit in the lower right hand corner admitted of rapid insertion and withdrawal of a sterile corked flask to contain the latex. This slit was sealed up by medical tape each time it was used.

This chamber was attached to an eight-years-old budded rubber tree yielding about 200 ccs. of latex per tapping. Tapping was discontinuous depending upon the requirements in the laboratory. All samples were brought to the laboratories, drops extracted by platinum loop and plated out in agar without dilution. Agar slope smears were also made. Of the 23 samples only Nos. 1 and 15 were found to be sterile. The quantity of latex obtained under these conditions varied usually from 100 to 200 ccs. but occasionally loss occurred through latex overflowing the tapping cut when the yield, as was the case in sample No. 15, would be as low as 60 ccs. as compared with over 150 ccs. in sample No. 1.

During storage at room temperature (26°-30°C.) samples 1 and 15 behaved in a similar manner. After removal from the tapping chamber at 10 a.m. the samples remained fluid till 10 p.m. but by 7 a.m. next morning coagulation had taken place, the coagulum being at the bottom of the flask and a thin milky serum at the top. When fully coagulated a firm white coagulum free from bubbles was formed, the serum being incorporated with coagulum except for the milky surface layer. There was no trace of bad smell until after the 7th day when, possibly through contamination on removal of cork for testing, the surface of the coagulum began to decompose and bad smell ensued.

Of the remaining 21 samples collected nine consisted of clean latex containing very few bacteria. In these samples coagulation was slow. It commenced at the bottom of the container and formed at the top a milky flocculate which failed to coagulate completely even after 72 hours. The lower true coagulum was firm and white, free of bubbles and sweet-smelling for at least 48 hours but on the 3rd day gas production and bad smell were present. Tests with colour indicators showed that there was little change in pH even on the second day.

One sample of latex was tapped in an atmosphere of nitrogen and collected in two flasks one flask containing the first portion of the yield as it flowed from the cut and the other the last portion. Bacteria were shown to be present in both samples and they coagulated within 24 hours with separation of a milky serum in upper surface layers. Putrefaction became noticeable after the second day of storage.

The remaining twelve samples contained from 10,000 bacteria per ml. upwards and finally a more or less uniformly high number of bacteria and all behaved in a similar manner, coagulating overnight with bubble (gas) formation and an accompanying bad odour. Many of these samples were collected in two parts, and it has been found that the first portion of the yield contained many times more bacteria than the second portion and also that the former coagulated in a shorter time than the latter.

It is inferred that bacterial action is not the only factor concerned in the natural coagulation of latex though it enhances coagulation under certain conditions. The coagulation of the two sterile samples of latex within 24 hours of tapping indicates that coagulation can take place without the influence of any external agency either bacterial or chemical and without any appreciable change in acidity.

Advisory Work.

Visits and Interviews—

Visits to Experiment Station and Small-holdings—		
Advisory	75	151
Experimental	76	
Visits to Estates other than Experiment Station—		
Advisory	4	116
Experimental	112	
Interviews at the Institute		82

Specimens Examined—

Leaves	58
Roots	43
Bark	6
Stumps	18
Branches	29
Seedlings	21
Fructification fungus, etc.	7
Cover plants	33
Cockchafers, and other insects	58
Fungicides and insecticides	7
Total	280

LECTURES—

1. "Root Disease Control in Young Rubber Areas" by R.P.N. Napper. Incorporated Society of Planters and District Planters' Association, Kajang, at Kajang Club, on 29-3-40.
2. "Inoculation of Leguminous Cover Plants" and "Root Disease Control in Young Rubber Areas" by R. P. N. Napper. Incorporated Society of Planters and Kelantan Planters' Association at Kuala Krai, on 25-4-40.
3. "Inoculation of Leguminous Cover Plants" by K. P. John. Batang Padang Branch of Estate Asiatic Staff's Association at Sungkai, on 18-5-40.
4. "Inoculation of Leguminous Cover Plants" by K. P. John. Estate Asiatic Staff's Association at Kuala Pilah, on 24-11-40.
5. "Root Disease Control" by R. P. N. Napper. Incorporated Society of Planters, Central Perak Branch, on 27-11-40.

PUBLICATIONS—

Note on the Preservation of Latex by Sterilisation in the presence of a Buffer Solution, by W. S. Davey and F. Beeley.

J. Rubb. Res. Inst. Malaya, Vol. 10, Comm. 149.

CIRCULARS—

One Circular (No. 11 Drought and Fire Damage, by F. Beeley), was issued during the year.

ADVISORY LEAFLETS—

P/AL. No. 1 (1940)—Termites—The White Ant Pest of Hevea by F. Beeley

P/AL. No. 2 (1940)—Spiders, Mites and Leaf-spot Fungi Damage of Leaves of Young Hevea Trees by F. Beeley

P/AL. No. 3 (1940)—Control of Root Disease in Preparing Areas of Old Rubber Trees for Replanting by R. P. N. Napper

P/AL. No. 4 (1940)—Stump-Poisoning with Sodium Arsenite by R. P. N. Napper

TOURS—

(a) *Mr. Napper:* Johore, Malacca and Negri Sembilan (1-2-40—3-2-40), object—Replanting. Kelantan (24-4-40—26-4-40), object—Root Disease Control in Mature Rubber.

(b) *Mr. FitzGerald:* Negri Sembilan (2-1-40—6-1-40), object—Control of Cockchafer Pest. Pahang (12-2-40—27-2-40), object—Cockchafer Grubs and Forest Ecology. Negri Sembilan (10-4-40—12-4-40), object—Cockchafer Pest. Selangor and Perak (26-4-40—30-4-40), object—Cockchafer Survey. Perak (7-6-40—10-6-40), object—Cockchafer Survey. Perak (19-9-40—25-9-40), object—Soil Injection for Control of Cockchafers. Selangor and Perak (8-10-40—17-10-40), object—Soil Injection for Control of Cockchafers.

KUALA LUMPUR,
8th May, 1941.

F. BEELEY,
Head of Pathological Division.

ANNUAL REPORT.

CHEMICAL DIVISION.

STAFF—

The establishment strength of Research Officers has remained the same as that of the preceding year. The appointment of a Chemist to fill an existing vacancy on the staff has not been made. Mr. Piddlesden returned from leave during the early part of the year, resuming duty in March, and taking over the advisory work from Mr. Wentworth. Mr. Sekar, Assistant Chemist, proceeded on leave in May and returned to duty in September.

The calls of military service have interfered considerably with the normal duties of the staff. Mr. Piddlesden was away for two months of the third quarter of the year and Messrs. Hastings and Wentworth for a similar period during the last quarter. The writer has continued on duty throughout the year.

Changing circumstances have necessitated changes in the nature of the work and the problems with which the Division has been called upon to deal. This has caused some unavoidable interference with the normal programme of work but it has nevertheless been possible to meet the demands which have been made upon the Division and at the same time to continue in a restricted form the main general investigations in progress.

Latex.

GENERAL—

The demand for preserved field latex and concentrated latex has fluctuated considerably during the year. It fell off markedly following the changes which took place in Europe during the middle of the year resulting in the complete closing of European markets, whilst simultaneously a reduction in the quantity of latex required by the United States occurred. However towards the end of the year there appeared to be evidence of an upward trend in the demand by American manufacturers.

Several factors appear to have contributed to the reduction of exports to the United States. At the outbreak of the war large orders for latex were placed but at the same time the increased cost of latex corresponding to the rise in the price of rubber slowed up its rate of consumption and hindered developments, particularly in the field of sponge-rubber upholstery. By the early part of the year most of the American manufacturers had accumulated considerable stocks and in view of the uncertain political situation it was not surprising that they adopted a conservative programme concerning the use of latex and the developments of new lines. This attitude was assisted by the assurance that shipments were coming forward in increasing quantities, lessening the risk of a possibility of any shortage in the immediate future. In addition several large manufacturing companies have become less dependent on market supplies by developing latex production on their own estates particularly in the Netherland Indies and Liberia ; the latex exports from the latter country have increased considerably during the year.

Chemistry and Technology—

It is well known that changes take place in the chemical constitution of the constituents of latex on storage which affect both its physical properties and the rubber prepared from it. A study of these changes has been made with particular reference to the changes in acetone extract and fatty-acid value. It was pointed out by Rhodes (*J.R.R.I.M. Communication 238*) that the acid constituents of ammonia-preserved latex gradually increase on storage and that on ammoniating fresh latex an apparent fall in the acid content of the latex takes place simultaneously. The changes in free fatty-acid constituents of latex may be due to (a) hydrolysis by ammonia (b) the results of periodical outbursts of bacterial activity and (c) the effects of enzyme action. Information on these points has been obtained by observing the changes which take place in latex sterilised in the presence of ammonia and bactericides and also by noting the effects of materials which are known to promote or poison the activity of enzymes. It has been observed that sterilisation increases the fatty-acid content of ammonia-preserved latex and that the subsequent changes which take place on storage are relatively small as compared with those which take place in unsterilised ammonia-preserved latex. Evidence has also been obtained which shows that these changes are not caused by bacterial activity in well-preserved latex.

An interesting observation has been made that the acid value of a dried film prepared from latex immediately after ammoniation is approximately the same if the degree of ammoniation is above a certain value. The effect of the concentration of ammonia on the rate of formation of acidity in latex has also been investigated and although a slight increase in acidity on storage does occur with an increasing ammonia content it is not particularly marked.

The changes in acid value which take place in latex are closely connected with those taking place in crepe and sheet during and after manufacture. The initial fatty-acid content of crepe is relatively low but this gradually increases under the conditions of ordinary estate manufacture where drying is carried out at comparatively low temperatures. If, however, the crepe is dried at high temperatures the changes which take place in acid value are relatively very much smaller. The evidence which has so far been accumulated appears to show that acid formation in both ammoniated latex and crepe is due to enzyme action which is arrested at elevated temperatures.

The effect of different conditions of storage on the formation of acid in dried latex films has also been observed. Films prepared from fresh or ammoniated latex eventually attain the same acid value when stored at ordinary laboratory temperatures (28° C.) under atmospheric conditions. When films from fresh latex are stored under absolutely dry conditions the acid value increases but to a smaller extent than when they are stored under ordinary conditions. When, however, dried films from ammoniated latex are stored under similar dry conditions practically no change in acid value occurs after three months. These results can be explained on the assumption that the ammonia sterilises the latex and prevents the subsequent formation of bacterial enzymes whereas in the case of fresh latex the bacterial enzymes formed continue to exert a hydrolysing effect for some time. These results are being confirmed and explored further.

A number of samples of caoutchol have been prepared and forwarded to the Director of the British Rubber Producers' Research Association at his request. Some work has been done on eliminating the possible oxidation effects during the drying of the films prior to the determination of the caoutchol.

During the year Bloomfield and Farmer (*Trans. I.R.I.* 16, 1940, 69) described a new procedure for the fractionation of rubber by means of petroleum ether-acetone mixtures in which successive extractions are made with mixtures containing increasing proportions of petroleum ether. The fraction extracted by a mixture containing equal parts of the solvent (petroleum ether) and the precipitant (acetone) has been described as the "oxide fraction." One or two of the analyses of this oxide fraction given in Bloomfield and Farmer's paper appear to be very similar as regards composition to that given by Roberts for caoutchol and moreover the oxide fraction and caoutchol appear to be similarly affected by ammonia. Roberts's procedure differed from the above only in so far as he used a mixture of a solvent (carbon tetrachloride) and a precipitant (acetone) for the dissolution of the rubber and then added a further quantity of the precipitant, leaving the caoutchol in solution, whereas Bloomfield and Farmer used the solvent and precipitant together for extraction purposes. If caoutchol is identical with the oxide fraction one would anticipate that it would be almost completely soluble in a 50:50 mixture of petroleum ether and acetone. The Director of the Rubber Producers' Research Association suggested that we might investigate this point. It has been found that the bulk of the caoutchol does dissolve in this mixture but dissolution is very slow and only takes place over a very long period. Samples of caoutchol are being kept under different conditions of storage and their solubility in the mixture ascertained by noting what changes take place.

Testing—

The British Standards Institution has published standard methods of testing latex which are based on those in use in the laboratories of the London Advisory Committee and are similar to those in use in the laboratories of the Rubber Research Institute. The methods described do not call for any special comment.

The desirability of estates and suppliers of latex using standard methods for the determination of the dry-rubber content of latex has been emphasised in the press. In view of the developments which have taken place in the latex industry it became necessary to review the Institute's position regarding the analysis of latex samples on behalf of estates and others concerned in the purchase and sale of latex and to discriminate between services given by the Institute solely for the purposes of trade in contradistinction to those given for the purposes of development and research. The Institute has moreover offered to give personal tuition at its laboratories to members of estates staffs and a number of estates concerned with latex production have taken advantage of this offer during the year to send members of their staff to the Institute for the necessary training. Full details of the proposals regarding the analysis of latex samples were published in the *R.R.I. Planters' Bulletin* No. 9, 1940.

QUALITY—

Discolouration. In previous Annual Reports reference has been made to the practice of lining drums, particularly second-hand drums, with a zinc oxide-latex mixture. The objection raised to the use of zinc oxide has been its adverse effect on the stability of latex. It has been previously reported that experiments have been made with titanium oxide-latex mixtures and that promising results were obtained. The experiments were carried a stage further by shipping to England kerosine tins of latex in which this type of lining was used. The reports received, however, were not encouraging. An alternative proprietary waxy material, which is marketed for a similar purpose in America, has also been examined with the object of ascertaining its suitability as a lining for drums containing latex. Kerosine tins lined with this material were also sent to England and more satisfactory reports were received, although the condition of the wax in the air space above the latex was somewhat faulty. During the year the prices of second-hand drums have risen considerably and with the slackening demand for latex the number used has fallen off. It has therefore been decided to postpone this investigation until a more suitable period arises.

PRESERVATION—

A number of materials have been examined to ascertain their effectiveness as preservatives in latex. It has been observed that by increasing the amount of ammonia to 0.2 per cent. a material reduction in the quantity of disinfectant required for adequate preservation can be effected. Several materials which are marketed in America as stabilisers have been found to be effective preservatives when used in conjunction with this proportion of ammonia. Guaiacol used as a sodium salt has also proved itself to be an efficient preservative but it has the disadvantage of imparting an unpleasant odour to the latex. The following substances have been found to be valueless even in the presence of 0.2 per cent. of ammonia when used in concentrations of from 0.1 to 0.3 per cent.:—dibromo-quinono-chloramide, sodium phenylphosphate, tetra potassium pyrophosphate, Cominal G.A.R., carvacrol and parachlormetacresol.

It has been observed that some of the materials which preserve latex in the presence of small amounts of ammonia are themselves coagulants when used alone. The problem of preservation has been approached from a new angle by using inorganic salts in the presence of small amounts of ammonia and it has been found that very small amounts of these materials are sufficient to give adequate preservation.

The Pathological Division has co-operated in the work on latex preservation. Although evidence has recently been brought forward to show that the development of acidity arising from bacterial action does not provide a full explanation of the spontaneous coagulation of latex, bacterial determinations do nevertheless give a valuable indication of the possible efficiencies of latex bactericides as preservatives of latex particularly in the early stages of preservation. A rapid attainment of sterility usually foretells adequate preservation. This was illustrated in the case of some tests made with sodium pentachlorphenate and the sodium salt of benzylated chlorphenol. With sodium pentachlorphenate used in the proportions usually recommended latex became sterile on the second

day of preservation. With 1 per cent. of sodium pentachlorphenate in the absence of ammonia the latex was sterilised almost immediately and showed no evidence of bacteria in any of the subsequent counts which were made. It has been observed that such latex keeps for a year without showing evidence of coagulation. On the other hand bacterial counts on the latex containing 1 per cent. of the sodium salt of benzylated chlorphenol (no ammonia) indicated that this material was ineffective in completely destroying bacteria, with the result that it soon coagulated although in the intervening period the bacteria were apparently quiescent.

Following the publication of a technical bulletin by the manufacturers describing the use of Santobrite as a preservative of rubber latex a review of the properties and economic possibilities of this material was published in the *R.R.I. Planters' Bulletin*, May, 1940. The use of Santobrite as a preservative of latex has now been fully investigated and it has been proved conclusively that it is efficient in the presence of small quantities of ammonia. Criticism has been directed against its use mainly because of its toxicity. We are of opinion that as far as the plantations are concerned this danger has been over-emphasized and provided that elementary precautions are taken when handling the material we do not consider this objection justifies the emphasis which has been laid upon it. Up to the present the material has not been used extensively in Malaya owing to import restrictions. The magnitude of its future use will depend on the demands of consumers; if these demands increase they can be met by the producers.

It is well known that it has not been possible to eliminate ammonia entirely when using other preservatives. Supplies of ammonia for commercial use are dependent upon an adequate number of cylinders being available, and as an excessive quantity of these does not exist at the present time mishap to a consignment in transit might cause a shortage. Preliminary experiments have been made to ascertain if these small quantities of ammonia could be replaced by materials which can be handled more easily. Urea was tried for this purpose, as it is cheap, and easily transported. The experiments showed that approximately 0.5 per cent. was required to replace the ammonia which it is necessary to use in conjunction with Santobrite. With smaller quantities the latex coagulated immediately, but with larger quantities an evolution of ammonia was observed owing to the hydrolysis of the urea. Other ammonium salts were also investigated but were not found to be as satisfactory as urea.

In the Annual Report for 1939 reference was made to investigations on the preservation of latex by autoclaving in the presence of a buffer solution. A note has since been published in the *Institute Journal, Communication No. 249*, in which it is shown that (a) diluted fresh latex, buffered or unbuffered, is more resistant than concentrated latex to clotting and coagulation on sterilisation by autoclaving, (b) de-ammoniated latex is more resistant than fresh latex to clotting or coagulation on sterilisation by autoclaving, (c) buffered latex sterilised by autoclaving is non-resistant to bacteria and is therefore unstable and coagulates when exposed to infection.

Data showing the effects of the addition of ammonia of different strengths on the bacterial population in field latex are included in the paper.

Concentration—

Centrifuging. The cheapest and most efficient machines for the centrifugal concentration of latex have hitherto been obtained from Germany or Sweden and are now no longer available. It is understood that American-made machines are available but these are expensive and moreover their entry into Malaya is subject to import restrictions. The increase in export allowances has also reacted on the centrifugal concentration of latex, since the value to the estate of the rubber remaining in the skim fraction has greatly increased. It is anticipated that the demand for concentrate will gradually revive, but a larger margin above the price of ribbed smoked sheet may be necessary to make the process attractive to the producer.

When machines are running efficiently the skim fraction usually contains from 6 to 8 per cent. of rubber which is strongly protected by the serum substances and coagulation is therefore difficult. In appearance the rubber from the skim resembles certain lower grades of crepe and complaints have been received that it is sometimes classified with other lower grades which have markedly different processing properties. It is desirable that some system of identification should be evolved whereby a buyer would always know when he is buying this type of rubber. Experiments have been carried out in order to formulate simple tests for the identification of the skim crepe.

With low rates of release many producers have found it uneconomic to recover the rubber from the skim fraction, but with high rates of release this rubber cannot be disregarded. Renewed attempts are being made to develop an improved process for recovering the rubber from the skim fraction and it is hoped, as a result of work now in progress, that it will be possible to recommend alternative methods for utilising the skim fraction.

In spite of the difficult conditions which have prevailed in the latex market during the year, several estates commenced production for the first time and assistance has been given in designing and starting up plants. These were operating at the end of the year although at a somewhat reduced capacity. In one or two other cases factories have been constructed and the supplementary machinery installed, but owing to the difficulty of obtaining machines considerable delays have been encountered in commencing manufacture.

A paper giving the results of experimental work with various machines was prepared for presentation to the Paris Rubber Conference held in May. This paper was subsequently published as *Communication 250* in the *Institute Journal.* It reviews the question of the concentration of rubber latex as a general problem, details the performances of a number of commercial machines which had been available up to the time of the publication of the paper for operating the centrifugal process and finally discusses the practical aspects of the process from the point of view of the plantation rubber producer in the East.

A centrifugal machine manufactured by an English firm has been loaned for testing in the laboratories of the Institute. This machine is smaller than the usual type of centrifuge and has a correspondingly smaller throughput but it was thought to contain

the nucleus of a commercial apparatus. Its performance, however, was not satisfactory, but a number of improvements were suggested to the manufacturers.

Creaming. Samples of methyl cellulose were received from manufacturers through the medium of the London Advisory Committee. The manufacturers stated that solutions of the materials had a wide viscosity range. Although we were unable to confirm the actual values given, the solutions did show marked differences in viscosity. It was anticipated, by analogy with the work done with Manucol solutions of varying viscosities, that these would have an influence on the optimum amounts necessary for creaming, but the creaming efficiency of the highest viscosity material was not so good as that of Tragon Seed gum even when using twice the quantity, and moreover the rate of separation was slower. The relatively low efficiency of methyl cellulose taken in conjunction with the cost and the observations that the solutions contained flocculent material does not encourage the possibility of its being used commercially as a creaming agent.

A paper summarising the work on creaming agents was written for the Paris Rubber Conference and will be published in the *Journal*. It gives a description of the factors which should be taken into consideration in evaluating creaming agents and indicates that the cost should be balanced against that of the service it gives and the influence it has on quality. The efficiency of the creaming agent is determined by the optimum amount required under specified conditions of preparation and testing. A method of determining the optimum amount is described and some observations are made on the manner in which this is affected by the manufacture, preparation and keeping properties in the case of some of the commonly used creaming agents. The general differences between creamed and centrifuged latex are enumerated but it is pointed out that little information is available to enable a discrimination to be made between latex prepared by different creaming agents.

The prevailing opinion has been that adsorption of the creaming agent on the rubber particle is an essential corollary of creaming but more recently Bondy (*Transactions of the Faraday Society* **35**, 1939, 1093) has produced convincing evidence that adsorption of the creaming agent does not take place and further that if adsorption does in fact occur it is detrimental to the creaming process. Bondy's views have been supported in a paper by Hauser (*Industrial and Engineering Chemistry* **33**, 1941, 127). Both of these workers used alginates as the creaming agent; these are known to have adsorption properties different from those of other creaming agents. Observations made in these laboratories on the effect of creaming agents with fresh latex find a ready explanation based on the assumption that the creaming agent is not absorbed on the rubber globules and produce additional evidence in support of the views put forward by Bondy and Hauser. It is anticipated that a paper describing this work will be published in the *Journal* shortly.

Technological Studies of Rubber.

General and Testing—

The Crude Rubber Committee of the American Chemical Society published a report (*Rubber Age* **47**, 1940, 102) reviewing its activities during the five years which have elapsed since its inception. This Committee represents the consumers of crude rubber in America and

its views are therefore of special interest to the producers of plantation rubber. Some of the principal matters dealt with in the report are commented upon below :

(a) *Sampling*—

The Committee reports that no standard procedure is available for sampling rubber but that it has this subject under consideration. The factors involved in obtaining a representative sample of rubber from a consignment are not dissimilar from those generally involved in sampling any solid material. The evolution of a method requires the collection and examination of data, which is a fairly straightforward problem in statistical methods. The accumulation of such data would however entail a considerable amount of testing, which could best be carried out in the consuming countries. It is felt that a statistical examination is necessary before formulating a defined method of sampling, and the lines on which it was considered that the investigations could best be made were suggested to the Committee.

(b) *Age Resistance*—

The Crude Rubber Committee is endeavouring to ascertain whether a practical compound, tested by an accepted standard resistance test, will show that crude rubber free from deleterious substances demonstrates variations in its resistance to the test. Many types of ageing tests are in use in the rubber industry and it is not surprising that these have resulted in "a mass of fluctuating data". This Institute is equipped both with the Geer oven and the Bierer-Davis oxygen bomb type of ageing apparatus. A simple rubber-sulphur mix was used formerly for the examination of the ageing properties of crude rubber, which were compared by noting the decrease in tensile strength after ageing for various periods of vulcanisates cured to the same state of cure. The use of this mix was criticised on the grounds that it was not representative of technical practice and it was said that the differences observed were either exaggerated or would not be apparent in an accelerator mixing. Similar criticisms were made against the use of a rubber-sulphur mixing for the determination of the rate of cure, but evidence has since been obtained which shows that a considerable degree of correlation exists between the results given by the rubber-sulphur mixing and the captax mixing (*J.R.R.I.M. Communication No. 243*).

For the purpose of testing age resistance the rubber-sulphur mix was subsequently replaced by the following diphenylguanidine mix:— Rubber 100, Zinc Oxide 5, Sulphur 4, D.P.G. 0.75. With this mixing it is necessary to submit samples from a range of cures to ageing tests. Many of the investigations on the ageing properties of crude rubber in which the rubber-sulphur mix was used have been repeated in the diphenyl guanidine mixing and the results have confirmed those previously observed with the rubber-sulphur mixing. As an example, it was previously found that the ageing properties of smoked sheet were impaired if the sheet was subsequently dried in hot air and these results are confirmed in the diphenylguanidine mixing. It is apparent from evidence which has been accumulated that this mixing indicates that appreciable changes in the ageing properties of rubber are produced as a result of comparatively small changes in methods of preparation.

(c) *Rate of Cure*—

We are in agreement with the Committee regarding the desirability of establishing a single basis of comparison for the rate of vulcanisation of rubber in the Committee's standard recipe. The basis which has been used as a criterion of cure in the Institute's laboratories for a considerable time is the modulus at an elongation of 700 per cent. in a 60-minutes cure at 127°C. The Committee now recommends that if a single cure be used it should be "the 40-minutes cure at 126°C. (260°F.) and the modulus 700 per cent.".

In 1936 Somerville circulated data to all members of the Rubber Division giving the physical properties of stocks from slow and fast curing rubber cured in the American Chemical Society "Captax" mixing at 127°C. The Committee has now reverted to 126°C. although 260°F. is actually nearer to 127° than to 126°C. The difference in temperature is not large but it is hoped that the Committee will clarify the position by definitely fixing the temperature in degrees centrigrade at which vulcanisation is to be carried out. If this is not done there is a risk of confusion which will not help to eliminate differences in the results of tests shown by different laboratories.

Of far greater importance in this respect are the differences in the design of vulcanising and testing equipment and the technique of testing followed in different laboratories which make it difficult to correlate results. This is well illustrated by a distribution curve of moduli at 700 per cent. relating to the tests of a large number of samples which are included in the Report. The average modulus figure of 99 kg./sq. cm. at 700 per cent. elongation for a 40-minutes cure is considerably higher than that previously obtained in these laboratories for a 60-minutes cure *viz.* 52 kg./sq. cm. No doubt this difference is partly accounted for by the use of dumb-bells test-pieces instead of rings but this can hardly comprise the whole explanation. Somerville's data for fast and slow curing rubbers showed a modulus of 86 and 47 kg./sq. cm. respectively for 40-minutes cures at 127°C.

His fast curing rubber must therefore be considered as slow when judged by the figures in the distribution curve of the Report since its modulus falls on the lower side of the values lying within the range of the standard deviation (86.4—111.6 kg/sq. cm.). The data in the Report do not include any sample having a modulus as low as 47 kg./sq. cm.

(d) *Variability*—

In view of the difference in mean values of the samples observed by us (*loc. cit.*) and those reported by the American Crude Rubber Committee, a trustworthy comparison of variabilities is difficult, since we have little information regarding the relationship which exists between the variability of modulus and its magnitude. If it is independent of the magnitude, for which we have some evidence, we would conclude that our investigations and those of the Committee are equally variable. However, at present we cannot reach any conclusion about the relative variabilities of the two series of samples.

The statistical theory used to arrive at the conclusion that 70 per cent. of the values lie within the range of the standard deviation i.e. between 86.4 and 111.6 kg./sq. cm. is based on the assumption that the moduli are normally distributed, but actually this is not the case. The curve is not a true Gaussian curve. By the simple method of

measuring the areas on the graph published in the Report we find that about 77-78 per cent. of the rubber tested in this survey had a 700 per cent. modulus of between 86.4 and 111.6 kg./sq. cm.

An examination of the data presented shows quite clearly that considerable work on the standardisation of testing will have to be done before absolute standards for the evaluation of crude rubber can be adopted. It is hoped that the Committee will continue to collect such data, and if a scheme of cross-testing could be instituted it would provide valuable information.

Variability of Sheet Rubber—

The investigations referred to in the Annual Report, 1939, relating to rubber from estates which are known to produce fast and slow vulcanising smoked sheet have been extended and samples have been received which were representative of each daily crop. We are indebted to the managers of estates for the trouble taken in supplying us with the samples and ensuring that they were as representative as possible of the whole estate crop. Samples were taken daily at first for about a month and subsequently at regular but less frequent intervals. It is necessary that the collection and the examination of these samples should continue over a considerable time in order to cover all periods of the year. The results so far obtained indicate that the variability of rubber from individual estates is less than that which exists between rubber from different estates. It has been previously observed that rubber from young trees is generally faster curing than that from old trees; more recent observations indicate that young rubber is more variable than old rubber when prepared under standard conditions.

Rubber has also been prepared under standard estate conditions at the Experiment Station and samples have been collected and tested daily for a period extending over eight months. These are composite samples derived from a number of clones and seedling areas of relatively small acreage upon which different tapping systems are used. This rubber has been found to be fairly uniform; the combination of different genetic strains, and of different tapping systems, probably tends to reduce variability.

Investigations concerning the effects produced on the physical properties of rubber by varying the controllable factors have continued at the Experiment Station under estate conditions. In this connection it may be noted that the effects produced by the use of sulphuric acid judged by the results so far available confirm our opinion that the use of this acid is undesirable on account of its retarding influence.

Determinations of the day-to-day variation in the vulcanising properties of sheet prepared from seedling trees at the Experiment Station (Field 23) in which the trees are tapped by different systems have been observed for a period of one year. Arrangements has also been made to obtain daily samples of rubber from a series of experiments in which different tapping systems on budded trees are used. We are indebted to Dunlop Malayan Estates Ltd. for granting us the necessary facilities to obtain these samples. Evidence is accumulating that the nature of the tapping system has a considerable influence on the physical properties of sheet rubber and that it is an important factor in the variability problem.

There are indications that with a system where the intervals between tapping are longer than usual, as for example the full-spiral fourth-daily, the rubber is faster-vulcanising despite the fact that the system may be continuous and not include a resting period.

A considerable amount of replanting is now taking place in Malaya and this is often preceded by a preliminary period in which the areas to be eradicated are submitted to a period of intensive tapping commonly known as "slaughter" tapping. The Botanical Division has a series of experiments in hand designed to determine the effect of intensive tapping on yield, and advantage has been taken of these experiments to investigate the quality of the rubber when prepared under standard conditions. Intensive tapping has a considerable effect on the dry-rubber content of the latex and it has also a marked effect on the vulcanising properties of the rubber. A correlation appears to exist between the original dry-rubber content of the latex and the variability of the rubber. Some systems in use have a big influence and if an area of an estate in slaughter-tapping is extensive there is little doubt that the properties of the rubber from that estate would be altered considerably.

Plasticity--

Samples of rubber from clones P.B. 186 and Tj. 1 were obtained through the courtesy of the Director of the A.V.R.O.S. Proefstation. The plasticities of rubber from these clones confirm the results previously obtained and show that P.B. 186 is outstandingly plastic. Determinations of the plasticities of rubber from the Experiment Station and from estates referred to above have been made. Rubber prepared from individual trees of R.R.I. clonal families which are likely to be widely planted in the future have been investigated. The results indicate that none of these produces rubber that is particularly soft but that some are worthy of selection on this account if other characteristics are the same.

A series of observations has been completed to ascertain what relationship if any, exists, between the plasticities and the "caoutchol" contents of films prepared from latex from a number of trees which have been found to give rubber of varying plasticity. The data have not yet been examined critically but it appears that the caoutchol-content of rubber from the same tree varies considerably from day to day whilst the plasticity remains fairly constant.

Work has continued on the development of a power-consumption test to be correlated with plasticity determinations using smaller quantities of rubber than are usually needed. The results obtained by this test indicate conclusively that P.B. 186 is invariably softer than Tj. 1 irrespective of the source from which it is obtained.

Modified Rubber.

Low Water-absorption Rubber—

In the Annual Report for 1939 reference was made to the accumulation of data relating to the effect of several factors influencing deproteinisation of rubber by enzyme action. Most of the investigations have been carried out with papain, activated with alkali cyanides. The activating effects of a number of other less poisonous substances have been examined and it is hoped that it will be possible to publish the accumulated data during the year.

One of the material factors to be considered in the evolution of a method for the preparation of low water-absorption rubber is the effect the enzyme has on the stability of the latex. This has been found to be considerable and has constituted a technical difficulty, but a means of minimising it has now been found. The problem of stability and other factors impose limitations on the translation of methods on a laboratory scale to those on a commercial scale but it has now been possible to work out a process applicable to large-scale production. Several large samples of rubber specially prepared have been sent to the United Kingdom and America during the year, but in the prevailing circumstances any reactions must necessarily be slow. A favourable report has been received from American consumers who have informed us that they are interested in commercial quantities.

The examination of the water-absorption properties of a series of crepes and smoked sheets from selected estates has been extended to include that of the vulcanised material. This has necessitated work on the formulation of tests suitable for the purpose and a paper is in course of preparation describing these. Co-operative tests on raw rubber have been made with our colleagues of the Ceylon Rubber Research Scheme and the London Advisory Committee.

Softened Rubber—

Previous work on the action peptising agents on rubber has been confined to ascertaining their effect in conjunction with a heat treatment. This has been extended to investigate their effects in the absence of a heat treatment as in the case of air-dried crepe. A marked effect on plasticity has been observed.

Few developments have occurred in peptising agents. One chemical, *a*-nitroso-*b*-naphthol was examined, but its peptising effect was not so good as that of R. P. A. 2 or R. P. A. 3.

Applications have been made for provisional protection for three processes evolved in the laboratories for the preparation of softened rubber. In one case applications have also been made to obtain protection in the U.S.A. and the Netherlands Indies. The manufacture of softened rubber on a commercial scale has been carried out by an estate in this country using one of these processes. The dislocation in Europe, however, has interfered with the marketing of the material.

Estate Supplies.

In the Annual Report for 1939 reference was made to the position which existed following the outbreak of war as regards the supply of coagulants. During the first quarter of 1940 the position eased somewhat and although formic acid continued to remain scarce throughout the year plentiful supplies of acetic acid became available and this acid has since been in general use. The temporary shortage of formic and acetic acids encouraged a large increase, during the early part of the year, in the importation of sulphuric acid, the extended use of which is considered to be detrimental to the general quality of Malayan rubber. The same problems confronted other rubber-producing countries. The marketing of sulphuric acid mixtures of unknown composition has proved to be

a lucrative business and its extension has been indicated by the increase in the number of samples of coagulants received for analysis from official and trade sources particularly during the early months of the year.

A system of control of the imports of sulphuric acid was instituted during the year whereby this could be imported only by permit, the object being to limit the quantity imported to that of the level of the average of the pre-war years. Two of the Unfederated Malay States prohibited completely the importation of sulphuric and hydrochloric acids unless required for special purposes. Although considerable stocks of sulphuric acid were held in different States and are still being used by small-holders, the effect of the restriction is to diminish its use which is in fact showing a satisfactory decrease. Nevertheless, ingenuity is still being evinced to obtain approval for the use of coagulants which it is claimed do not contain sulphuric acid.

Although there has been no actual shortage of imported coagulants the efforts to explore the possibilities of utilising native materials in the event of a shortage have continued. Many local vegetable products give rise to acidity on fermentation but the amount is relatively small and moreover shows a considerable variation. These factors limit the utility of these materials to cases where they can be fermented on or near the estates where they are used and if only relatively small quantities are required. Nevertheless, attempts have been made to work out a scheme for the fermentation of materials whereby continuous supplies of the acidic material would be available. By manipulation of the fermentation of toddy it has been possible to effect improvements in the direction of eliminating the variability in acid content and fairly promising results have been obtained. Another material which might be used in an emergency is the extract of tamarind fruit which gives a higher acidity content than many other vegetable materials. It would, however, be troublesome to prepare on an extensive scale.

Details of the use of serum which had already been published as an advisory circular were described in *Journal Communication No. 252*. This paper describes the development of a method for using less formic acid by utilising serum in the preparation of smoked sheet. It is shown that the serum remaining after coagulation can be used to reduce the amount of fresh acid required for the next coagulation and that this can be repeated on several successive days. The limitations of the method are described in the paper and the properties of the rubber obtained by the use of this method are compared with those of rubber prepared by the standard method of coagulation with formic acid.

Several samples of pyroligneous acid obtained by collecting the vapours from charcoal kilns and also by the distillation of coconut shells have been examined. The acid content of these liquids is about 10 per cent. and the crude materials can be used as coagulants but, as in the case of plant extracts, the problem of the high transport and freightage costs on a material containing a big proportion of useless water, together with the problem of the cost of containers, rules out the possibility of utilising these materials, except locally, unless economic methods of concentration can be evolved.

Supplies of other materials which have been affected include aluminium equipment, plywood cases, metal gauze for latex strainers and certain chemicals such as paranitrophenol and sodium sulphite.

Aluminium Equipment—

Aluminium is in considerable demand for the manufacture of essential war equipment and the metal has been difficult to obtain. The matter of supplies was raised with the Rubber Growers' Association who made enquiries on our behalf as to the possibility of small quantities being allotted for use by the plantation industry. This was not considered to be possible but nevertheless fairly regular supplies have been obtainable throughout the year from non-sterling countries.

Plywood Cases—

The cessation of the export of plywood cases from Scandinavia caused a shortage of packing cases despite the increasing number which have been manufactured locally. The shortage has inevitably caused increasing prices as compared with those ruling before the war. The deficiency has, to some extent, been supplied by cases from Canada, Japan and China and more recently from Australia ; samples of plywood obtainable from these different countries have been examined in the laboratory by means of an empirical set of tests which were worked out and applied to a fairly wide range. These tests showed that good locally-made plywood compared favourably with the best imported varieties. The shortage of plywood cases has given an impetus to the export of rubber in the form of bales, which is referred to below.

Metal Gauze—

The matter of adequate supplies of metal gauze for straining latex has also caused some concern. Brass gauze is still being largely used despite the continued and emphatic advice to the contrary given by the research organisations which advise the use of Monel metal. Supplies of brass gauze, however, have been difficult to obtain from England and other sterling countries, but inquiries made in England on our behalf have satisfied us that adequate supplies of Monel metal are available to meet all the requirements of the industry.

Paranitrophenol—

Supplies of paranitrophenol have fluctuated and at times this material has been difficult to obtain. The higher export release, however, which has the effect of reducing the need for storing rubber before shipment, has caused a material reduction in the demand for paranitrophenol. Moreover, in cases when it has been unobtainable other suggestions have been made to estates to prevent possibilities of mould formation on sheet. A number of materials have been examined in order to ascertain their potentialities as mould preventatives but none of these has equalled the efficiency of paranitrophenol on a cost basis. Santobrite, for example, is efficient but about four times the quantity has to be used as compared with the quantity necessary in the case of paranitrophenol. Although the latter has increased in price during the year and Santobrite is considerably cheaper this does not counterbalance the extra quantity of Santobrite which it is necessary to use. One other promising material has been examined but it has the disadvantage of giving a slightly white and noticeable film on the surface of the sheet.

Sodium Sulphite—

The shortage of sodium sulphite has not been acute but other materials such as soda ash have been experimented with as possible anti-coagulants. Recommendations for the use of this material in place of sodium sulphite could be made if necessary.

Estate Technique.

Smoke-houses—

The two experimental smoke-houses of the Tunnel type at the Experiment Station have continued to operate successfully throughout the year and we know of 30 Tunnel smoke-houses now in operation throughout the country. The design has also been introduced into Burma, Ceylon and British North Borneo. Several modifications of the standard design have been introduced by various estate managers and contractors and as a result of the experience gained from smoke-houses in operation certain small alterations in the plans can now be recommended; several other suggestions which have been made by estates as a result of their experience are being examined. Estates which are known to have Tunnel smoke-houses in operation have been asked to give us the benefit of their experience so that the best possible advice may be placed at the disposal of the industry.

A new design of Tunnel smoke-house, type C, has been produced to meet the needs of estates concerned with large crops. One such building is now in course of construction and two other estates have the design under consideration. As soon as the smoke-house is proved to operate successfully a description will be published. Several articles dealing with smoke-houses have been prepared and published in the *R.R.I. Planters' Bulletin*. An article dealing with the prevention of fires in smoke-houses was published in No. 14 of the *R.R.I. Planters' Bulletin*.

Scrap-drying Shed—

An experimental scrap-drying shed has been designed and is now in course of construction at the Experiment Station. If this is satisfactory particulars will be made available to all those interested.

Packing of Rubber—

Considerable work has been carried out on the packing of rubber in bare-back bales and a review of this question was published in the *R.R.I. Planters' Bulletin* No. 12 (July, 1940). Experiments dealing with the evolution of an apparatus for producing baled rubber have been in progress at the Experiment Station; and a paper is in course of preparation. The apparatus has been demonstrated already to several planters who are interested in this method of packing rubber and trial shipments of bare-backed bales have been despatched to America and the United Kingdom. The experiments have proved that this type of packing can be carried out cheaply on estates without the aid of special equipment; provided that the market reports are favourable it is anticipated that this method of packing will be much more widely adopted.

Samples bales wrapped in proprietary reinforced paper have also been prepared and despatched to England. The report on these is still awaited but our own experience indicates that this method is not likely to compare favourably with bare-back baling.

Dirt in Rubber—

Further complaints of sand and grit in smoked sheet have been received from the manufacturers through the London Advisory Committee, and several new refinements to be used in connection with the settling of latex before coagulation are under investigation. In this connection a survey of current estate practice is being carried out and in order to obtain the necessary information a questionnaire was circulated at the end of the year.

Advisory Work.

The advisory work of the Division has again shown a substantial increase as compared with the previous year and has made increasing demands on the time of the staff. The appendix to the Director's report gives an analysis of the correspondence of the Division from which it will be observed that 1,290 letters were received and 1,593 letters were despatched. This compares with corresponding figures of 931 and 1,356 respectively for 1939. The increase in correspondence has to some extent been accounted for by the prevailing circumstances. Considerable advice concerning the use of alternative coagulants was given, particularly during the first quarter of the year. The subsequent stabilisation of the coagulant position resulted in a reduction in the number of inquiries although the change over from the use of formic to that of acetic acid has needed much attention.

There has again been a big increase in the number of inquiries relating to smoke-houses. These have arisen partly because of the destruction or the inefficiency of existing smoke-houses and also partly because a number of estates which have been concerned with latex have had to turn over to smoke sheet manufacture. Advisory letters on smoke-houses have reached a total of 240 during the year ; many plans and drawings have been supplied to estates and contractors. From letters which we continue to receive it is apparent that the Tunnel smoke-house is capable of giving very efficient service and where it does not we are satisfied that it is because some adjustments in manipulation are required.

The number of samples examined during the year almost equalled the high level reached during 1939 (700). This year the number was 680. The number of estate managers and other visitors to the Institute has shown a marked falling off, which is perhaps not surprising in view of the bigger demands made on estate staffs. Altogether 213 visits were paid by members of the staff to estates ; 14 tours of an advisory nature were made during the year.

The staff has been consulted frequently by the Controller of Restricted Imports regarding the import of materials required by plantation and manufacturing companies. At the request of the Chairman of the Malayan Delegation to the Eastern Group Conference a comprehensive report was submitted regarding the actual and potential manufacturing capacity of the rubber industry of Malaya.

Collaboration has been maintained throughout the year with the London Advisory Committee, the Ceylon Rubber Research Scheme and the British Rubber Producers' Research Association through the interchange of progress and monthly reports, although communications have been more infrequent owing to difficulties in transport. Contact with the Crude Rubber Committee of the American Chemical Society has been maintained throughout the year.

Visits were received from Mr. O'Brien, Director of the Ceylon Rubber Research Scheme and Dr. Kraay, Director of the Proefstation West Java, during the early part of the year in connection with the Conference of Directors of Research, Mr. Van Dalfsen, Proefstation West Java, also spent some time at the laboratory and discussed with the Staff matters of mutual interest. No visits overseas were made by any member of the Staff.

The Malayan Agri-Horticultural Show was not held and there was no small-holders rubber competition. Meetings arranged by the Planting Associations were fewer and only one lecture was given, *viz.*, to the Kuala Selangor Branch of the Incorporated Society of Planters.

We have again to record our appreciation of the willing co-operation of the Research Department of Socfin Co. Ltd., Dunlop Malayan Plantations Ltd., the Malayan Research Laboratories of the B. F. Goodrich Co., Wilkinson Process Rubber Co., Ltd., Diethelm & Co., Ltd., Shum Yip Leong Rubber Works and the managements of numerous estates who have assisted us by preparing samples and in many other ways.

Lectures.

The following lecture was given during the year :—

Lecturer.	Place.	Title.
W. S. Davey	Kampong Kuantan Estate, Bukit Rotan, Selangor.	"Latex Concentration"

Publications.

Publications in the *Journal of the Rubber Research Institute of Malaya* were as follows :—

Communication 249 Davey & Beeley : Note on the Preservation of Latex by Sterilisation in the presence of a Buffer Solution (June, 1940).

" 250 Piddlesden : The Concentration of Latex by Centrifugal Machines (August, 1940).

" 252 Wentworth : The Use of Serum as a Latex Coagulant (October, 1940).

Publications in the *R.R.I. Planters' Bulletin* were as follows :—

No. 9—Baling or Packing in Cases ?
Analysis of Latex Samples

No. 10—Estate Manufacturing Costs

No. 11—" Santobrite " as a Preservative of Latex

No. 12—The Baling of Sheet Rubber

No. 14—Prevention of Smoke-house Fires
R.R.I. Tunnel Type Smoke-house
Questionnaire on Cleaning of Latex
Estate Manufacturing Costs
Estate Supplies in War time .

W. S. Davey,
Head of Chemical Division.

Kuala Lumpur,
25th March, 1941.

ANNUAL REPORT.

EXPERIMENT STATION.

Acreage Statement.

Planted	31-12-1940	1,228.16 acres
Gardens and Cleared Land	.. .. ..	10.00 ,,
Building Site and Roads	.. .. ..	66.18 ,,
Reserve Jungle	.. .. ..	47.16 ,,
		1,351.50 acres

Details.

In bearing on 31-12-1940	.. .. ..	812.50 acres
Immature and Nurseries	.. .. ..	415.66 ,,
		1,228.16 acres

Not included in the above statement are two seed gardens totalling 10 acres in the Forest Reserve. These areas are held under permit and are reserved for work on *Hevea spruceana*.

Distribution of Land.

Botanical Division	.. ..	915.58 acres
Soils ,,	.. ..	258.58 ,,
Pathological ,,	.. ..	16.00 ,,
Chemical ,,	.. ..	34.00 ,,
Small-Holders' Advisory Service	.. ..	4.00 ,,
		1,228.16 acres

Botanical Division Areas.

New Clearings—

All the remaining plantable land on the Station, comprising four small areas of $38\frac{3}{4}$ acres in all, was planted up during the year.

Three of these areas, Field 41 ($6\frac{1}{2}$ acres), Field 42 (10 acres) and Field 43 (13 acres) had been felled in 1929 to form an elephant belt and consisted of long narrow strips on the Station boundaries.

All three areas were opened up without burning following closely the method which is fully described in the *Annual Report*, 1939, pp. 218-220, with the exception that contour planting was unnecessary, the land being either flat or slightly undulating.

Considerable damage was again caused by rodents and necessitated heavy supplying with basket plants painted with "tanglefoot."

The cost for the first year are shown in the following table :

	Fld. 41 ($6\frac{1}{2}$ acs.)		Fld. 42 (10 acs.)		Fld. 43 (13 acs.)	
	Total cost.	Cost p. acre	Total cost.	Cost p. acre.	Total cost.	Cost p. acre.
	$	$	$	$	$	$
Clearing 6' Strips ..	45.50	7.00	77.42	7.74	104.78	8.06
Lining	1.72	0.26	3.18	0.32	6.36	0.49
Cutting 4' Platforms	13.78	2.12	—	—	16.17	1.24
Lalang	15.38	2.37	3.73	0.37	31.96	2.46
Weeding	47.11	7.25	113.24	11.33	106.34	8.18
Holing and Filling ..	—	—	20.31	2.03	43.03	3.31
Felling	79.06	12.16	120.72	12.07	182.12	14.01
Clearing after Felling	100.15	15.41	150.90	15.09	238.18	18.32
Planting and Supplying	23.71	3.65	29.53	2.95	31.40	2.41
	326.41	50.22	519.03	51.90	760.34	58.48

It was originally intended to utilise the fourth area (Field 44. $9\frac{1}{4}$ acres) as a multiplication nursery for the supply of budwood to smallholders. The area was consequently burnt-off and partially cleared. Subsequently it was found necessary to use the area as an extension to Field 34 and budded stumps of new clones established from the 1938 hand-pollinated crosses were planted in October. The boundary rows and a small swampy area were planted with clonal seedling stumps.

NURSERIES—

(a) *Main Multiplication Nursery.*

Budwood of certain clones, which was no longer required, was eradicated and the beds were dug over and replanted with germinated seed for budding later. Several more beds of seedlings were budded with new clones.

(b) *Hand-Pollination Nursery.*

The old hand-pollination nursery is gradually being abandoned as seedlings are removed. A new nursery of $\frac{1}{2}$ acre was established on the western side of the cattle area and the 1940 crosses were planted out here after liberal manuring with compost.

(c) *Clonal Seed Nursery.*

Most of the material from this nursery was removed for supplying experimental areas. Remaining material was eradicated and the nursery was heavily manured with cowdung and replanted with germinated clonal seeds.

Field 39 Nursery (4 acres).

This nursery was manured with 2 cwt. Enpekay 5 per acre and a few beds were budded with new clones.

Immature Areas.

1938 Clearings. Field 34. (40.5 acres).

This area was divided into 108 plots and was budded with the new clones established from the 1938 hand-pollinated crosses, with Clone Pilmoor B. 84 as a control clone.

The stumps of the 1938 hand-pollinated seedlings were also planted out in certain plots. Original unselected seedlings which had to be removed to accommodate these stumps were budded with Tj. 1, Tj. 16, P.B. 86 and P.B. 25 and transplanted as budded stumps in Field 36 nursery.

This field was originally maintained under a mixed cover of indigenous species and *Centrosema pubescens*. The leguminous creeping cover is growing vigorously and has smothered most of the natural covers.

Field 35 (30 acres). Planted May, 1938.

Over part of this area the jungle was frill-girdled and poisoned with sodium arsenite; control plots were opened up under the normal light-burn method. There are three plots of 5 acres each under each methods of treatment.

All poisoned jungle trees which had not fallen were felled and strips six feet wide were cleared along the planting rows in the poisoned area. Surprisingly little damage was done by the felling and a high percentage of the original stand of 360 trees to the acre remained buddable. Half-plots were budded and thinningout will be done in 1941. The planting material consists of illegitimate clonal seedlings and buddings made on clonal seedling stocks.

1939 Clearings. Field 38. (59 acres).

In this area, which was opened under the "no burn" method, rodent damage throughout the year was considerable and as supplying was carried out over such an extensive period the growth is uneven. Natural covers appeared very slow to regenerate as a thick mat of BERTAM ATTAP lay over most of the area.

Field 32 and 33. (63.25 acres). Planted November, 1937.

These areas are budded with new clones from the 1937 hand-pollinations. Growth of the young buddings has been good.

The mixed cover of natural species and *Tephrosia candida*, which had not recovered from the severe caterpillar attack in 1938, received a dressing of Enpekay 5.

Field 30. (40 acres). Planted October, 1935 (without burning).

This area comprises a clone trial of clones R.R.I. 500 to 522 with Pil. B. 84 as a control. Growth remains satisfactory and natural covers are still very strong.

Field 27.

In this field five different types of planting material, namely clonal seedlings of Avros 49, Avros 50, unselected seedlings, mixed clonal seedlings and mixed buddings are being tested under five different methods of cultivation three with natural covers treated in different ways and two under leguminous bush and creeping covers respectively.

All seedling plots were test-tapped by the standard 10-day test method in January. Trees were classified according to yield and the stand per acre was reduced from 180 to 120. Seedling plots were brought into tapping on July 1st.

Covers in treatments 1, 3, 4 and 5 received a dressing of 2 cwt. of basic slag per acre. (Treatment 2 under creeping legumes was manured in 1939).

Field 26. Clonal seed trial. (10 acres).

This field was brought into tapping in February.

Thinning-out was carried out to reduce the stand per acre to 120 from 180.

Forestry covers received a dressing of 2 cwt. per acre of basic slag.

The terraces were reconstructed by removing earth from the bank in the rear and forming a bund along the front edge.

Summary of Tapping Experiments—

Field 5 (40 acres). Planted November, 1929.

Tapping continued on the same three systems as in 1939. (see *Annual Report*, 1939, p. 223). A new panel was opened at 40 inches from the union on July 1st on trees tapped s/2,d/2,100% and s/2,d/1, 1m/2,100%.

Field 21. Polyclone area of seven clones.

The tapping systems employed during 1939 were continued during 1940 except for modification of the periods of rest and tapping in the "periodic series." The changes were made to provide information on the optimum periods of rest and tapping for the different clones.

The systems employed were:

Series 1 All clones s/2,d/2,100%.
,, 2 All clones s/2,d/1,30d/60,100%.
,, 3 All clones s/1,d/4,100%.
,, 4 Clone C.T. 88 s/2,d/1,24d/48,100%.
,, 4 Clone Avros 256 s/2,d/1,48d/96,100%.
,, 4 Clone Avros 50, 71, BD. 10, SR. 9 and Tj. 16 s/2,d/1,36d/72,100%.

A new panel was opened at 40 inches from the union on July 1st on all trees except those tapped s/1,d/4,100%.

Fields 22A and 25 Section 5. (*Two Height-of-tapping experiments on budgrafts and seedlings respectively*).

In December the panels originally opened at 20 inches had reached ground level. Both experiments will be discontinued in 1941 and the fields will return to normal tapping on the new panel.

Field 19A. (*Single-task tapping experiment on B.D.5*).

Tapping in this area continued on the same systems as in 1939. (see *Annual Report*, 1939 pp. 224—225).

Field 18A. (*Experiments on full-spiral tapping*).

This field, approximately 40 acres planted with a collection of 16 proved clones in rows, was prepared for a new series of tapping experiments to test various forms of full-spiral tapping systems.

Field 18C. (*Slaughter-tapping experiment*).

The same six systems were employed in this area as in 1939. (see *Annual Report*, 1939 p. 224).

Botanical Division General—

Distribution of Budwood and Clonal seed.

Budwood totalling 9,834 yards and 7,000 seeds were dispatched to experimental areas in various parts of Malaya. Budwood of ten of the R.R.I. 500 series Clones measuring 3,906 yards was dispatched to estates in many parts of the country.

Hand-Pollination Work.

Mr. C. C. T. Sharp's artificial hand-pollination work was continued with selected clones. A number of scaffoldings were erected for this purpose.

Root Studies.

Root observation work was continued under Dr. Baptist's control.

Measurements.

Girth measurements were taken by Field Assistants resident on the Station in all Botanical Division fields.

Soils Division Areas.

Manurial Trials—

Field 6 (*40 acres*). *Seedling trees.*

Application of fertilisers was at higher level in 1940 than in previous years in order to correspond more closely with the age and size of the trees.

A. Control—Unmanured.

B. Organic—84 lb. cowdung per tree.

C. Complete inorganic. 4 lb. Enpekay No. 1 per tree.

D. Nitrogen—$2\frac{1}{2}$ lb. sulphate of ammonia per tree.

E. Nitrogen and Phosphate. $2\frac{3}{4}$ lb. Nicifos B. per tree.

F. Potash and Phosphate. 2 lb. mixture (sulphate of potash and double superphosphate per tree).

Fertilisers were applied in 8 ft. forked strips between rows.

In future fertilisers will be applied biennially.

Field 13A (2½ *acres*). *Replanted 1936. Budded with Tj. 1 in October, 1938.*

The following fertilisers were applied during February:

Plots A and D—6 oz. Enpekay No. 2 per tree.

„ B and C—6 „ Complete inorganic (special mixture) per tree.

Field 23 (*36 acres*). *A comparative test of Enpekay No. 1 and Sterameal Young Rubber Mixture.*

Application of fertilisers continued as in previous years.

Treatment 1—Control—No manure.

„ 2—3 lb. Enpekay No. 1 per tree.

„ 3—4 lb. Sterameal Y.R. Mixture per tree.

Field 17D (*North*). *Manurial Trial on Clonal Seedlings* (*Annual Report 1937*).

The following fertilisers were applied in April and October:

A. Control—Unmanured.

B. 19 oz. Sulphate of ammonia per tree.

C. 19 oz. Sulphate of ammonia + 22 oz. Superphosphate.

D. 19 oz. Sulphate of ammonia + 10 oz. Sulphate of Potash.

E. 19 oz. Sulphate of ammonia + 22 oz. Superphosphate + 10 oz. Sulphate of Potash

F. 22 oz. Nicifos B.

H. 19 oz. Sulphate of ammonia + 16 oz. ground limestone.

Field 31 (*38.75 acres*).

A manurial trial replicated six times on buddings of Tj. 1, B.D. 5, P.B. 86, B. 84 and D. 65. (*Annual Report*, 1936).

The following fertilisers were applied in May:

A. Control—No manure.

B. 10 oz. of Sulphate of ammonia per tree.

C. 10 oz. Sulphate of ammonia + 4 oz. potassium chloride per tree.

D. 11 oz. Nicifos B. per tree.

E. 4 oz. Potassium chloride + 5 oz. concentrated superphosphate per tree.

F. 16 oz. Enpekay No. 1 per tree.

Field 36 (*2 acres*). *Nursery Manurial Trial* (*Annual Report, 1939*).

All plots in the stock nursery were thinned-out during February leaving a stand of 105 plants per plot.

Budgrafting was carried out in April with Pil. B. 84. Unsuccessful buddings were cut back to the same height as successes.

Fertilisers were applied in January, April and July.

Field 17C (6 acres). Replanted October, 1938.

This area was budded during April with Pil. B. 84 and Lunderston N. in alternate rows.

In October 6 oz. per plant of a special fertiliser mixture were applied.

Soils Division, General—

Field 9 (8 acres).

No further application of phosphate was made to this area during the year. The growth of the centrosema still remains very poor. (see *Annual Report*, 1939, p. 228).

Field 19. Cultivation Experiment.

Digging-in of grasses in this area continued as in previous years.

Measurements.

Girth measurements were taken by Divisional Field Assistants in all Soils Division fields according to programme.

Leaf Analysis.

Collection of leaves for analysis continued in manurial and clone trials.

Compost.

A number of experimental compost heaps were made during the year using oil palm bunch or pericarp refuse as a basis and combining various other materials with them. In all 35 tons of compost was manufactured and used in multiplication and other nurseries. The most satisfactory combination appears to be a mixture of oil palm bunch refuse and Mikania cuttings in a proportion of two to one. Heaps made with oil palm pericarp refuse were not successful.

Pathology Division Areas.

Routine inspection and treatment for all diseases was carried out during the year over the whole Station.

Summary of Work Done.

	Trees treated.	*Trees removed.*	*Total.*
Fomes lignosus	1,501	404	1,905
Ganoderma pseudoferreum ..	366	112	478
Fomes Noxius	151	35	186
Ustulina zonata	163	37	200
Termites	4,841	336	5,177
Pink disease	1,104	44	1,148
Total ..	8,126	968	9,094

Fields 7 and 8 (20 acres). Seedling trees planted December, 1928.

As in 1939, diseased trees in these fields were inspected regularly but not treated. The limits of spread of infection were demarcated with a paint band after each inspection.

Termites.

The methods of treatment previously in use (see *Annual Report* 1938, p. 182) were discontinued in March in favour of a standard treatment with mercury perchloride throughout the Station.

Experiments were carried out under the Entomologist's instructions designed to control termite attack by destruction of queen termites.

Sulphur Dusting.

Five rounds of sulphur dusting were carried out with the power machine in March and April to control a serious attack of thrips.

There was no attack of Oidium during the year.

Experimental Garden.

The old phosphate nursery (0.5 acre) was taken over by the Entomologist and planted with various cover crops and Hevea seedlings for the study of insect attack, soil injection, etc.

Field 37 (8 acres).

This area continued to be used by the Pathological Division for testing sprays, chemical dusts, etc.

Chemical Division Experiments.

Experiments on the Properties of Clonal Seedling Latex—

Sample sheets were taken daily from the three different tapping systems on seedling trees in field 23 and sent to the Chemical Division.

Sample sheet was also made daily from the nine different clones in field 5, the seven different tapping systems in the slaughter-tapping experiment in field 18C and from the B.D. 5 latex taken from field 24.

Samples of clonal and seedling latex from field 18A were sent regularly to the Chemical Division.

Latex from *Hevea spruciana* in jungle plot A was sent regularly to the Chemical Division for the last part of the year.

Experiments on Properties of Rubber Manufactured under Varying Conditions—

Throughout the year one 80-gallons tank of latex was specially prepared, varying in D.R.C.—use of different coagulants—method of machining—times of soaking, dripping and smoking.

Another 80-gallons tank of latex, manufactured under standard conditions, was used as control. Samples were cut from all sheets and dispatched to Chemical Division together with a record of weights, etc.

SMOKE-HOUSES—

The furnace of the Old Tunnel smoke-house was rebuilt.

One of the old Kampong smoke-houses was dismantled and a new one erected.

BALING—

A "Bare-back" baling press was installed in the old A.P.C. air-drying room and experiments were carried out on baling. Experimental shipments were sent to London and America.

Routine and General.

SMALL-HOLDERS' BUDWOOD NURSERY (field 40—4 acres)—

This nursery, which was opened up at the end of 1939, was planted with germinated seed at the beginning of the year and will be budded in 1941.

MANURING—

It was decided to manure most mature fields alternate yearly after they had received an application for three consecutive years. Consequently the general manuring programme in 1940 was smaller than usual.

The special fertiliser mixture applied was as follows :

Sulphate of ammonia	5 parts	9.3% N
Nicifos B	2 ,,	
X'mas Island R.P. ..	3 ,,	8.7% P^2O^5
Sulphate of Potash ..	5 ,,	16.8% K^2O^2

Details of the fields, manures and quantities applied are given below :

Field.	Quantity per tree.	Age of trees.
4A	$2\frac{1}{2}$ lb. ..	$11\frac{1}{2}$ years
5	$2\frac{1}{2}$,, ..	11 ,,
10	$2\frac{1}{2}$,, ..	9 ,,
12	$1\frac{1}{2}$,, ..	4 ,,
13B	$3\frac{1}{2}$,, ..	$11\frac{1}{2}$,,
14A.B.	$2\frac{1}{2}$,, ..	9 ,,
14E	$3\frac{1}{2}$,, ..	9 ,,
14F	$3\frac{1}{2}$,, ..	9 ,,
15A	1 ,, ..	4 ,,
17A	$2\frac{1}{2}$,, ..	11 ,,
17D (north)	$2\frac{1}{2}$,, ..	9 ,,
17D (south)	$2\frac{1}{2}$,, ..	11 ,,
23A	1 ,, ..	4 ,,

ROADS AND PATHS—

Forty-five chains of the new road were constructed through field 38 thus completely encircling the south end of the Experiment Station.

The top ten chains of the hill road were abandoned and ten chains of new road were constructed as a deviation off the hill road to the northern boundary of field 38. It is intended to connect this road with the road along the southern boundary of field 38 in 1941.

DRAINS—

Heavy rains did considerable damage to the drains in hilly areas, which necessitated much repair work. The programme of bunding and canalising was continued.

BUILDINGS—

One set of five room lines for the labour force, similar to those built in 1939, was erected.

The old creche was converted into a tool store and a new and larger creche with tiled roof was erected.

A new carpenter's workshop was erected and the old workshop converted into living quarters for the carpenter.

The Botany Division weighing room was extended and fitted with cupboards and desks.

A three-room building with hardwood frame and atap roof was constructed to house the Malays on the staff.

ROUTINE WORK—

(a) *Tapping:*

There was no tapping on 15 days owing to holidays
,, ,, ,, 10 ,, rain
,, late ,, 59 ,, ,,
Rain interfered with tapping on 16 other days.

(b) *Upkeep Work:*

Routine weeding, slashing and patrol for lalang was carried out regularly as in previous years.

Repairs and renewal of fencing, bunds and terraces, were carried out where necessary.

MANUFACTURE, EXPORT AND REVENUE—

Details of crop dispatched for sale are as follows:

R.S.S.	360,743 lbs.	
Compo	53,526 ,,	
Cup Lumps	109,205 ,,	
		523,474 lbs.

Total revenue obtained from sale of rubber in 1940 was $172,808.02

Smoked sheet rubber weighing 17,926 lbs. was sent to headquarters for Experimental purposes.

RAINFALL—

Monthly rainfall figures for the Experiment Station are as follows :

January ..	7.98 inches	July ..	2.90 inches
February ..	2.78 ,,	August ..	8.54 ,,
March ..	4.86 ,,	September ..	6.95 ,,
April ..	7.38 ,,	October ..	10.57 ,,
May ..	10.71 ,,	November ..	12.91 ,,
June.. ..	2.92 ,,	December ..	16.65 ,,
	36.63 inches		58.52 inches

Total for the year = 95.15 inches.

LABOUR FORCE AND HEALTH—

Health throughout the year continued to be good. The following are the details of health returns and labour force for the year :

Workers.		Dependants.	
Men	199	Men	2
Women	104	Women	12
Children	39	Children	142
	342		158

	Admissions to Hospital.	Treated on Experiment Stn.
Malaria ..	2	.. 23
Injuries, etc.	7	.. 98
Confinements	21	.. 1
Deaths ..	2	.. 1

Average spleen rate for 1940.

Men	1.4 per cent.
Women	1.2 ,,
Children	1.6 ,,

LABOURERS' GARDEN—

Ten acres of reserve jungle to the west of field 6A were felled and burnt off and divided into 100 small plots for labourers gardens. The land has been cultivated and a keen interest is being shown in many gardens.

REFRESHER COURSES—

Nine courses of a week each were held for estate conductors. A total of 45 conductors attended.

The usual course of instruction in field and factory practice, lasting for one month, was given to a number of students from the School of Agriculture, Serdang, for selection of new Asiatic Rubber Instructors.

Selected candidates underwent instruction for a further month before taking up their appointments.

VISITORS—

A total of 311 visitors were shown round the Station, which is a big decrease over previous years, no doubt due to the outbreak of war and the embodiment of Volunteers.

Visitors to the Station included the Directors of rubber research organisations in the east who attended a conference in Kuala Lumpur.

We were again glad to welcome members of the Kuala Lumpur branch of the Estate Asiatic Staffs' Association.

EMBODIMENT OF THE F.M.S.V.F.—

Owing to the embodiment of the Local Forces the European staff had to report for training from July 8th to September 4th. Short periods of leave were however obtained from the military authorities so that one European was resident on the Experiment Station throughout the period.

STAFF—

We deeply regret to record the death on October 7th of Mr. T. N. Dickson, Manager of the Experiment Station.

Mr. Tovey joined the staff of the Experiment Station as Assistant in January.

Staff employed on the Station during the year was as follows :

Experiment Station Staff.	Staff attached from Head Office.
Manager: T. N. Dickson	
Asst. Manager: R. F. Harley	
Assistant: J. H. Tovey	
1 Chief Clerk	1 Senior Bot. Div. Field Assistant
1 Asst. Clerk	5 Other Bot. Div. Field Assistants
1 Typist	3 Bot. Div. Conductors
1 Dresser	1 Soils Div. Field Assistant
1 Field Conductor	2 Pathology Div. Assistants
1 Tapping Conductor	2 Chemical Div. Assistants
1 Asst. Tapping Conductor	1 Asiatic Rubber Instructor
1 Factory Clerk	

Again we have to record with appreciation the loyal assistance given during the year by all the staff, especially during the period of embodiment.

LECTURES—

Mr. Dickson gave a lecture on Replanting to the Kuala Lumpur D.P.A. in May.

ACKNOWLEDGMENTS—

Our thanks are due to the General Manager, Kepong (Malaya) Rubber Estates, Ltd., for allowing us to take visitors round replanted areas belonging to his Company ; also to our V.M.Os., Drs. Mackintosh, Hardy and Emery for all advice and assistance given throughout the year.

R. F. HARLEY,
Assistant Manager.

ANNUAL REPORT.

SMALL-HOLDERS' ADVISORY SERVICE.

General.

The Small-Holders' Advisory Service at the end of 1940 consisted of 36 Asiatic Rubber Instructors and 15 Asiatic Rubber Demonstrators, distributed throughout Malaya. These men are under the local day-to-day supervision of officers of the Malayan Agriculture Service, and are given advice and guidance from headquarters by a full-time Small-Holders' Advisory Officer (Mr. R. H. Meikle) with part-time assistance from the Personal Assistant to the Director (Mr. A. Moore) who is responsible to the Director. The Service went on normally in 1940, although receiving less attention than in 1939 and 1938. Mr. Moore was on long leave until the middle of August, and soon after that was away for two months on military training. During his absence Mr. Meikle carried out the duties of Personal Assistant to Director, and so could not give his whole time to the Small-Holders' Advisory Service. Furthermore, Mr. Meikle himself went on long leave early in December, which meant a prolongation of the difficulties experienced throughout the year, especially as Mr. Moore also took on the duties of Acting Secretary of the Institute from the beginning of December. Nevertheless during the year all Instructors, excepting the one in Brunei and certain new appointees whose States were visited before they went there, were visited at least once, about half were visited twice, and a few were visited three times. With the generous co-operation of the Agricultural Officers, who are responsible for the local supervision of individual Instructors and to whom our best thanks are due, and following the much closer attention given to the Service during the previous two years, the enforced reduction of supervision in 1940 appears to have had no ill-effects. Unfortunately it looks as if the conditions of 1940 as regards staff shortage due to leave and military service will be continued in 1941 so, to guard against deterioration of the Service, a scheme for having some of the senior Instructors visit and advise others of less experience was started towards the end of the year. This is described in more detail under "Superintendent Instructors".

Asiatic Rubber Instructors.

During 1940 six new Rubber Instructors were appointed, but two Senior Instructors were not re-engaged after their long leave following six years service, and one of the new Instructors resigned in October, giving a net increase of three since last year and making the total 36 at the end of 1940. One other Instructor submitted his resignation before the year end and arrangements have been made to replace him as soon as he leaves.

The new Instructors were, as usual, former students of the School of Agriculture, Malaya, and consisted of three Malays, two Chinese, and one Indian. Five came direct from the School, and one, a Malay, had one year's experience elsewhere before being appointed. In 1940 a more rigorous method of selecting was applied. All suitable candidates were invited to spend a month in working and studying at the R.R.I. Experiment Station, under close supervision. They were paid a small maintenance allowance to cover living expenses. At the end of that month the six best were selected as Asiatic Rubber Instructors and

trained for a further month before being sent out into the country. The unsuccessful candidates returned to their homes, with the benefit of a month of special training at no cost to themselves. One of them at least, and possibly others, made use of this training to obtain estate work.

The general duties of Instructors have been described in previous reports, and need not be enlarged on here.

Asiatic Rubber Demonstrators.

Asiatic Rubber Demonstrators were increased from 11 to 15 during the year and are now an established feature of the Small-Holders' Advisory Service.

Distribution of Asiatic Rubber Instructors and Asiatic Rubber Demonstrators at 31st December, 1940.

State or Territory.	Area of Small-holdings. Acres.	Instructors.				Demonstrators.	Average area of Small-holdings per Instructor (acres).
		Malay.	Chinese.	Indian.	Total.		
Perak ..	269,780	4	2	1	7	2	38,540
Selangor ..	148,480	2	1	1	4	1	37,120
Negri Sembilan	105,520	1	—	2	3	1	35,173
Pahang ..	98,607	3	1	—	4	3	24,652
Total F.M.S. ..	622,387	10	4	4	18	7	34,577
Malacca ..	71,129	1	—	—	1	—	71,129 (v)
Prov. Wellesley	23,858	1	1	—	2	1	19,513 (i)
Penang ..	15,167	Served by P.W. Instructors				—	—
Singapore ..	20,482	,, Johore ,,				—	—
Labuan ..	1,908	,, Brunei ,,				—	—
Total S.S. ..	132,544	2	1	—	3	1	36,718
Johore ..	384,533	4	2	1	7	—	57,859 (ii)
Kedah ..	96,604	3	—	—	3	—	33,406 (iii)
Perlis	3,613	Served by Kedah Instructors				—	—
Kelantan ..	60,337	2	—	—	2	4	30,169
Trengganu ..	27,396	1	—	—	1	2	27,396
Brunei ..	8,118	1	—	—	1	1	10,026 (iv)
Total U.M.S. ..	580,601	11	2	1	14	7	43,071
Expt. Station	—	—	1	—	1	—	—
Leave ..	—	—	—	—	—	—	—
Total Malaya	1,335,532	23	8	5	36	15	36,095

Notes.—

(1) (i) Includes Penang; (iii) Includes Perlis;
(ii) Includes Singapore; (iv) Includes Labuan;
(v) One Malacca Instructor temporarily at Experiment Station.

(2) Areas of small-holdings are taken from *Rubber Statistics Handbook, 1940.*

(3) All Instructors usually advise only small-holders of their own nationality, but will advise others if approached by them for advice and if there is no more appropriate Instructor conveniently near.

(4) The Service also advises smaller Asiatic estates, the owners or managers of which often do not know English. These amount to about 250,000 acres, making the total area which might come under the S.H.A.S. over *one-and-a-half million* acres, or almost *half* of the whole rubber area of Malaya.

The work of the Demonstrators has been described in previous reports, and here it need only be said that it consists of trying to drive in simple lessons by constant repetition of them to small-holders. At first, the Demonstrators learnt only the making of sheet rubber, followed by correct tapping methods. In 1940, the better ones have been allowed to learn and teach bud-grafting and to give elementary teaching on replanting. In general they are not entrusted with work which requires initiative, but repeat and repeat the simple lessons taught them by the Instructors. Success of most propaganda and teaching appears to lie in repetition, and amongst small-holders the spoken word seems to be more effective than any other method. This is especially so amongst the less sophisticated but harder working people of the eastern States. They are more backward, but in our experience are also more teachable. It is significant that half of our Demonstrators are in Pahang, Kelantan, and Trengganu, although these states contain less than one-seventh of the total small-holding rubber in Malaya. Demonstrators were introduced there as a cheap way of extending the scope of the Instructor's work in territory where travelling was often difficult, and where it was felt that the expense of more Instructors was not justifiable. They have been retained, and their number increased, because they have proved effective in consolidating our work.

So far all the Demonstrators have been Malays, excepting one Tamil who was employed during the bud-grafting season to give demonstrations on Indian estates. The Indian and Chinese small-holders usually know too much to pay attention to Demonstrators, or to profit by what they could tell them, and have to be approached by well-trained and educated Instructors. Even so, Indian and Chinese Demonstrators may be tried for special purposes if occasion arises.

Superintendent Instructors.

When the Small-Holders' Advisory Officer (Mr. Meikle) was appointed in 1938 there were less than 30 Instructors and only one Demonstrator. Before the end of 1941 there will be over 40 Instructors and 20 Demonstrators, and these numbers will be further increased in the next three or four years. It is thus becoming more difficult for the S.H.A.O. and the Personal Assistant to the Director to visit each man as often as is desirable. To overcome this difficulty, especially when one or other of the officers is on leave, it has been arranged for a few of the senior Instructors to visit and advise their juniors. These "Superintendent Instructors" are not yet to give up their own stations. Later they might, when they have had enough practice in "visiting" for it to be made a full-time job for one or two of them. So far no promotion is involved, but the work carries with it the possibilities of promotion.

It is too early to say whether the scheme is a success or not.

Instructor at the Experiment Station.

The practice of always having one Instructor at the R.R.I. Experiment Station for general duties and for special training has been continued. At the beginning of 1940 an Indian Instructor was in residence. He was followed successively by two Malays and a Chinese, the last being there at the end of the year.

The Chinese and Indians benefit most from the Experiment Station training, since they have more contact with medium and large properties in their regular work and thus have more opportunities of applying what they learn, but the Malays also find the training valuable and are becoming keen not to be overlooked.

Propaganda and Marketing Committee.

This Committee consists of representatives of the Co-operative Societies, the Agricultural and the Veterinary Departments, and of the Rubber Research Institute. It deals with all small-holding affairs which require the co-operation of the above Departments and the Institute. In 1940, as a result of discussion on the Committee, the Institute undertook to help, by means of its Instructors, in the training of unemployed Malay village youths to fit them for work on estates. The organisation generally is in the hands of the Co-operative Societies Department.

Small-Holders' Rubber Advisory Committee.

In 1940 the Board of the Institute approved the formation of a Committee to advise generally on matters connected with the Small-Holders' Advisory Service. The Committee consists of representatives of the R.R.I. Board and of the Malayan Agricultural Service, together with co-opted members. The first meeting was held in December, when the broader lines of policy and propaganda were decided upon.

Advisory Policy.

The most important item in the work of 1940 was replanting. Small-holders are realising, rather tardily, the advantages which the present Rubber Regulations confer in this matter, and the principal item in our advisory policy during this year has been to try to hasten replanting. On general grounds an *extension* of the area of small-holding rubber is perhaps undesirable, but it is highly desirable that the existing area of small-holding rubber land should be made as productive as possible. This can only be achieved by replanting, and the sooner it is done the better. For this reason replanting outweighed everything else in importance in 1940, and is likely to do so for several years to come. Other matters have not been neglected, but their relative importance has diminished. The preparation of good, clean, sheet rubber continued to be an important item of propaganda, but suffered a set-back when the increase of the export release to 100 per cent. reduced the penalties on poor quality "kampong" rubber. These matters are described in more detail below.

As in previous years the Small-Holders' Advisory Service gives advice to Asiatic estates, although they are not strictly small-holdings. When the owners or managers are unable to speak or correspond in English, it is more convenient for the Institute service to be given to them through the S.H.A.S. than direct from headquarters.

Preparation and Marketing of Rubber.

No marked change has taken place during the year, but the difficulty of obtaining correct coagulants, and more particularly the increased demand for rubber as a result of the war, have prevented improvement. In Pahang, where records were kept in connection with the grading scheme in force in that State, the proportion of first-grade rubber fell and that of lower grades rose with every increase in the exportable quota. This appeared to be the case all over the country. The actual *amount* of first-grade rubber from small-holdings may have

increased, but the *proportion* of it is lower. There has, however, been no return to the production of the very poor quality rubber which was so common a few years ago.

In Kelantan, Trengganu and Brunei large "kampong" smoke-houses are still being built. Some of these smoke-houses hold three or four *tons* of rubber, and are worked communally by a large number of small-holders. Elsewhere smoke-houses are usually small, with capacities of only one or two hundred pounds. Interest in smoking rubber is hard to maintain now. Many of the smoke-houses built since they were introduced in 1935 have collapsed and not been replaced. Others are idle, but are still of some value since their existence serves to keep in check the prices which rubber dealers charge for smoking sheet. A few are in regular use, and occasionally new ones are built. With the export release at 100 per cent., there is little incentive for the small-holder to smoke his own rubber. The smoking is, however, of secondary importance provided the rubber is *clean*. Our efforts to persuade the small-holder to make clean rubber have been maintained, but our insistence on smoking it under present market conditions has been relaxed. The time of the Instructors can now be spent more profitably in other directions.

The Co-operative Societies Department has continued its efforts to improve both the product and its marketing, and we have continued to help. So long as constant attention is given to the matter something can be done, but as soon as the small-holders are left to themselves they nearly always slip back into their old ways. It seems that, poor though they are, they are not alive to profit and are distrustful of co-operating to improve themselves. Also, in the matter of rubber production, the small-holders are so much in the hands of the general merchants cum rubber dealers that a large proportion of the benefit from any improvement would go to the latter, and the small-holders know it. It appears as if the all-round improvement which is obviously possible can only be achieved by action "from the top". This would probably mean Government buying of standard grades of rubber at standard prices, and refusal to allow the sale of more than a small proportion of rubber below a certain quality. The dealers would have to conform, or go out of business, and the average quality of the product would quickly rise. On a very moderate estimate it should be possible, by some such means, to improve the average value of the rubber produced on small-holdings by ½ cent per pound. With the present quota this would mean an extra two million dollars a year coming into the country, for nothing, which would be a great boon to the small-holders, and in war-time a valuable source of foreign exchange for the Empire.

There is no doubt about the ability of small-holders to produce first-class rubber. This has been proved year after year by the high quality of the entries at numerous rubber competitions all over the country. What appears to be needed is a judicious mixture of incentive and compulsion to induce them all to produce good rubber every day. In the scheme suggested above the incentive would be provided by giving a proper price for good rubber, and the compulsion by refusing to buy more than a certain small proportion of low-grade rubber. It is to be hoped that this scheme, or something similar, will be given a trial under conditions which provide a fair test.

(The observations in this section apply chiefly to Malay small-holders—the genuine peasantry of the country—and not so much to Chinese and Indians.)

Tapping.

Tapping is a most discouraging subject on which to advise small-holders. The benefit of good tapping is not immediately apparent, in fact good tapping by slightly reducing the crop may result in an immediate loss of revenue. Very few small-holders seem able to look far enough ahead to the time when they will have to tap renewed bark, and even when they can see thus far it seems too long to wait to reap the reward of careful tapping now. Partly as a result of this lack of foresight many holdings are leased or are tapped on contract, with no supervision from the owners, and the trees suffer accordingly.

Another, and most unsavoury, cause of bad tapping is the mortgaging of holdings. A mortgaged holding may be tapped by its nominal owner, but he feels that the holding is no longer really his, and might never be his again, so he has no reason to treat the trees properly. Often he has provocation for treating them quite otherwise. In fact the general indebtedness of small-holders is the principal bar to progress on all sides, not only in tapping.

Even on the better type of holdings, Chinese and Indian as well as Malay, if the bark consumption is less than double that of a European estate it is reckoned good. Only the long periods of no tapping in recent years, at times when the price of coupons was high and the price of rubber low, have saved the average small-holding from complete bark exhaustion. Small-holders will not even go to the trouble of keeping a check on bark consumption by putting monthly marks on the tapping panel. Our Instructors have for years tried to introduce this practice, but usually the putting on of monthly marks stopped when the Instructor ceased to see to them himself.

Small-holdings, in general, have now reached a stage where the standard of tapping, as regards both wounding and bark consumption, is less important than formerly since a very large proportion of them—about one million acres or three-quarters of the total—should be replanted during the next ten years. Also, in spite of discouragements, there has been *some* improvement in recent years. So, our propaganda on tapping is not pushed as vigorously as it used to be, but is still kept alive against the time when replanted small-holdings come into tapping and every effort must be made to have them tapped properly.

Treatment of Land and Soil.

Pests and Diseases.

Under these headings there is nothing to add to last year's report.

New Planting.

A general description of new planting as practised on small-holdings was given in the report for 1939 and need not be repeated here. Towards the end of 1940 a rough census was taken of the amounts of new planting being done under the advice of the S.H.A.S., and the results are shown in the adjoining table.

The area which has been newly planted, i.e., planted with rubber for the first time, was not increased in 1940 as the Rubber Regulations did not permit further new planting in that year, except in special circumstances.

Replanting.

Replanting on small-holdings was also described in the report for 1939. A rough census was taken of the amount going on under the advice of the S.H.A.S. at the end of 1940, and the results are shown in the adjoining table.

Replanting was permitted freely in 1940 and the replanted area extended rapidly. Complete figures are not available yet, but the figures already received give some idea of the progress being made.

Approved Application to Replant.

1-12-39 to 31-12-40.

(On small-holdings and on small Asiatic estates).

	Approximate No. of approved Applications.			Total Area approved (acres).
	Malay.	Other Asiatics.	Total.	
Perak	439	507	946	5,356
Selangor	119	239	358	2,971
Negri Sembilan ..	78	129	207	3,320
Pahang	44	28	72	632
Straits Settlements ..	30	114	144	2,247
Johore	Figures not yet available.		Estimated	6,000
Kedah	,,	,,	,,	2,000
Perlis	,,	,,	,,	50
Kelantan	,,	,,	,,	300
Trengganu	,,	,,	,,	200
Brunei	,,	,,	,,	50
	Estimated total area (acres) ..			23,000

On small-holdings and small Asiatic estates, approximately 20,000 acres were replanted up to the end of 1939, so that the total in hand at the end of 1940 is about 43,000 acres. The adjoining table shows that the Small-Holders' Advisory Service has succeeded in making direct contact with over half of this area. A large part of the remainder is believed to be in districts where Instructors are not stationed. As the Service extends most of these areas will also be reached.

Catch-Crops.

It is interesting to note that catch-crops are being grown on half of the Malay and Chinese holdings, in both new-planted and replanted areas. Normally we do not encourage catch-cropping, especially in replanting, because it is often done without taking proper care of the soil. During the present war-time emergency our objections have been partly suspended. Whilst not actively encouraging the growing of catch-crops, we are not discouraging it except in cases of replanting where the soil is obviously unable to support both rubber trees and

catch-crops. Where catch-crops are being grown the owners are warned against the possible dangers of soil exhaustion and soil loss, and advised to manure the rubber to offset the effects of competition.

Catch-crops are nearly always food crops, so the new planting and replanting of rubber are incidentally increasing greatly Malaya's economic ability to produce its own food at the very time when it is needed.

New Planting and Replanting

Under the advice of the

Small-holders' Advisory Service.

(*Rough Census at end of 1940*).

	Advised by			
	23 Malay Instructors.	8 Chinese Instructors.	5 Indian Instructors.	Total for 36 Instructors.
NEW PLANTING.				
Holdings being advised				
Total Area (acres) ..	9,300	11,100	2,300	22,700
Total No.	1,400	500	80	1,980
No. already budded ..	170	140	40	350
No. to be budded in 1941	540	300	30	870
No. planted Clonal Seed	50	10	10	70
No. growing Catch-Crops	630	250	10	890
REPLANTING.				
Holdings being advised				
Total Area (acres) ..	5,700	8,200	11,300	25,200
Total No.	900	450	270	1,620
No. already budded ..	100	120	100	320
No. to be budded in 1941	550	250	120	920
No. planted Clonal Seed	40	20	30	90
No. growing Catch-Crops	700	180	10	890

NOTE.—

Malay holdings are on the average very much smaller than Chinese or Indian holdings, and the work of advising them correspondingly greater since it takes as long to advise an owner with 3 acres as one with 30 acres. The average size of Malay "small-holdings, which account for the greater part of Malaya's small-holdings area, seems to be about 3 acres. The table above shows that the average size of *replanted areas* on Malay holdings is now about 6 acres. This suggests that so far only the owners of comparatively large Malay small-holdings are doing replanting. The numerous small men, the genuine peasants who in the mass are so important, have scarcely started. It is too early to give definite reasons for this, but there are strong indications that poverty is the general underlying cause and that some form of assistance will be necessary if Malaya's rubber-producing capacity, *vis a vis* its competitors, is not to fall seriously a few year hence.

The reader is reminded that the replanting data above represent the position at the end of 1940. There has been much replanting started since, and the figures are changing quickly.

High-yielding Planting Material for Small-Holders.

It has already been pointed out that something like a million acres of small-holding rubber land should be replanted within the next ten years. To ensure that both the individual owners and the country as a whole derive full benefit from this it is extremely important to impress on small-holders the desirability of using high-yielding planting material. Furthermore, it is essential to provide such material for sale to small-holders at a price they feel they can afford to pay.

Preliminary work in this direction was described in the report for 1939. In 1940 propaganda was intensified and practical arrangements for supplying the demand for budwood were extended. The larger and more responsible small-holders doing replanting were encouraged to establish their own budwood multiplication nurseries, and the nurseries of the Department of Agriculture were expanded to about 70 acres, distributed throughout the country at 23 Agricultural Stations. In addition, negotiations were commenced with Government for the establishment of a central budwood nursery of 150 acres, which the R.R.I. would organise and supervise if suitable land could be obtained near to the R.R.I. Experiment Station. Such a nursery, in addition to supplying all the budwood likely to be needed by small-holders, would also provide facilities for training many of the hundreds of budders who will be needed when small-holding replanting really starts.

The Department of Agriculture nurseries are not yet in full production, but have already proved their usefulness by setting a standard price which most other sellers of budwood have followed. During 1940 budwood was sold around 12 cents per yard, and budded stumps from 10 cents to 25 cents each according to the clone and the demand. A few estates have assisted greatly by supplying their surplus planting material to small-holders through our Instructors, at very reasonable prices.

The policy is still to advise small-holders to budgraft, in preference to planting clonal seed. There is no doubt that for small-holdings clonal seedlings would in many respects be better than budgrafts, but they unfortunately cannot claim the same assessment. At present, clonal seedlings are assessed as ordinary seedlings unless higher yields are proved. This is because in appearance they are not recognisably different ; because the yields of clonal seedling families have not yet been " proved " in the same sense as clones ; and because in any case proof of having bought or planted clonal seed is hardly acceptable (from small-holders) as proof that the trees to be assessed are clonal seedlings. It is hoped that as experience of clonal seedlings increases these difficulties will be largely removed. Meanwhile budgrafts, which are recognisable, and which we know to be high yielding and entitled to assessment accordingly, are recommended. Even so there are difficulties in the way of a small-holder who claims assessment for buddings, but these may be removed more easily.

The clones originally recommended to small-holders were the best of the "free" or non-proprietary clones, namely, Tj. 1, Tj. 16, Avros 49, Avros 50 and B.D. 5. In 1940 the proprietors of Pilmoor and Prang Besar clones relaxed their previous refusal to supply small-holders. It is now possible for the latter to obtain P.B. 25, P.B. 86 and Pil. B. 84, chiefly through the nurseries of the Department of Agriculture. Clones of the R.R.I. 500 series will also be available when " proved." Avros 49 and 50, B.D. 5, are no longer advised now

that there is a fair choice of better clones. Tj. 1 and Tj. 16 continue to be popular ; Tj. 1 being the most widely used of all clones up to date. Glenshiel 1 has been used on a few large holdings, and so have a few other proprietary clones, but not to any great extent.

Shows.

The big show of the Malaya Agri-Horticultural Association was cancelled owing to war conditions, and so were several others. Consequently there is no important activity to report under this heading.

Rural Lecture Caravan.

As in previous years a caravan, operated jointly by the Department of Agriculture, the Co-operative Societies Department, and the Rubber Research Institute, toured the rural districts in the F.M.S. and S.S. disseminating information on agricultural and other matters. Asiatic Rubber Instructors attended the caravan when it visited their districts, and gave lectures and demonstrations on rubber cultivation and preparation.

Experimental Work at Ampang.

A further small area, about one-half acre, was cut out and replanted in 1940, and the 1939 area was budded, thus continuing the plan of replanting a small area each year for demonstration. Growth on the previously replanted areas was good, excepting on one of the three areas planted in 1937 which has always been poor. This poor area is retained, as an example, although commercially it would be better to replant it afresh.

One-third of the nursery planted in 1939 in Block D, opposite the Institute, was budded in 1940. This is a demonstration nursery, but will also be useful as a source of planting material.

The Chemical Division continued to use the latex from these Ampang holdings.

Bark Survey on Small-Holdings.

The field work in connection with the survey referred to in the 1939 report was completed in 1940. The figures are now being analysed by the Statistician, and the results will be prepared for publication when the Small-Holders' Advisory Officer, who conducted the survey, returns from home leave.

Acknowledgments.

Much of the material in this report is derived from information collected by Mr. R. H. Meikle, the Small-Holders' Advisory Officer, before he went on home leave in December 1940. A great deal of this came, in turn, through the Instructors, who are dealing very satisfactorily with the increased work and responsibilities now attaching to their duties.

Kuala Lumpur,
13th February, 1941.

A. Moore,
Personal Assistant to the Director.

REPORT OF THE LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA) FOR 1940.

The Committee and Technical Sub-Committee held two meetings during the year. There were also two meetings of the Sub-Committee on Standardisation of Raw Rubber appointed in 1937.

The Committee regret to report the deaths of Sir Herbert Wright and Mr. B. D. Porritt, also the following resignations : Dr. W. Youngman Professor Clements and Mr. W. C. Smith. In view of Sir Frank Stockdale's appointment as Controller for Development and Welfare in the West Indies, he has been succeeded by Dr. H. A. Tempany as representative of the Colonial Advisory Council of Agriculture and Animal Health. Dr. J. R. Scott and Dr. S. Pickles are serving as members of the Technical Sub-Committee vice Mr. B. D. Porritt and Mr. W. C. Smith respectively.

Meetings of the Committee and Sub-Committees were attended by Mr. T. E. H. O'Brien, Director, Rubber Research Scheme, Ceylon, and the following members of the scientific staff of the Rubber Research Institute, Malaya, while on leave in this country : Messrs. C. E. T. Mann, J. H. Piddlesden and E. R. Guest.

CO-OPERATION WITH OTHER ORGANISATIONS.

Close co-operation was maintained throughout the year with the Research Association of British Rubber Manufacturers, whose help in connection with the work of the Standardisation Sub-Committee and in obtaining opinions of manufacturers concerning special samples of rubber and latex, was of particular value.

The Committee's staff attended the monthly technical discussions at the laboratories of the British Rubber Producers Research Association and at one of these meetings gave an account of the work in progress at the Imperial Institute.

FINANCE.

Contributions of £2,625 and £875 were received from the Rubber Research Institute and the Rubber Research Scheme, respectively, during 1940. Expenditure amounted to £3,916.14.6., leaving an unexpended balance of £1,182.13.10. at 31st December, 1940 ; the small increase in expenditure, as compared with last year, being chiefly due to the purchase of new equipment.

ACTION ARISING OUT OF THE WAR.

The staff undertook a successful investigation of a problem connected with Home Defence, the results of which may have peace time applications. A considerable amount of time was expended on this work, but the details naturally cannot be disclosed.

STANDARDISATION OF RUBBER.

The investigations on this subject again formed an important part of the work during the year. The Committee considered that as it would be difficult to introduce new market grades of clean and uniform rubber during the war, no action should be taken with a view to applying the conclusions obtained until more suitable conditions arise.

INVESTIGATIONS.

As a result of the investigations on latex a comprehensive picture of its structure is being systematically developed—attention being given not only to the nature of the substances present, but also to their situation and arrangement with respect to their physical relationships. The functions of different groups of substances and the factors determining quality are in consequence becoming more clearly defined. The information so far obtained is incomplete and the investigations are being continued, but the prospects of developing rational and practical tests for quality are definitely improved.

Preliminary work on the fractionation of rubber, ultimately connected with the possibility of obtaining different rubber hydrocarbons by selective propagation, has been in progress for some time and is leading to conclusions somewhat different from those obtained by other investigators. The results suggest that rubber contains a mixture of hydrocarbons which differ not so much in solubility as in rate of solution and that non-rubber substances can have marked effects on the rate of solution without necessarily affecting the size or chemical identity of the rubber hydrocarbon. Normal methods of testing may therefore yield misleading results concerning difference between hydrocarbon fractions and the possibility of devising a reliable test is under consideration.

In connection with the preparation on a large scale of clean and uniform rubber, attention has been given to the inconstancy of the same method of test carried out in different laboratories. It has not been found possible to eliminate all the discrepancies, but the problem is still under investigation, and there are several ways in which the difficulties may be overcome.

Manufacturers have displayed considerable interest in clean rubber and also in softened rubber prepared by a method devised by the staff of the Rubber Research Institute, Malaya, and large scale trials have been arranged.

REPORTS ON INVESTIGATIONS FORWARDED TO CEYLON AND MALAYA DURING 1940.

LATEX.

(1) Quality.

(*a*) Effect of Potassium oleate,

(*b*) Effect of Potassium palmitate,

(*c*) Properties of dried films from latex purified with soap.

(2) Applications of the Langmuir Trough.

(3) Examination of five samples from Ceylon.

(4) Effect of storage.

(5) Solubility of rubber from preserved latex.

(6) Antioxygens in latex.

(7) Determination of ammonia (NH_3).

(8) Gelling test.

(9) Fatty acids.

(*a*) Method of determination,

(*b*) Distribution between rubber and serum.

DRY RUBBER.

(1) The resistance to abrasion of special types of rubber.

(2) Low water absorption rubber.

(3) Effect of conditions of storage and accessory substances on the properties of rubber.

(4) Co-operative tests with the Research Association of British Rubber Manufacturers.

(5) Comparison of two Schopper machines.

(6) Softened rubber from Malaya.

(7) Standardisation of testing.

PATENTS.

As in previous years, the Rubber Research Institute, Malaya, and the Rubber Research Scheme, Ceylon, were supplied with copies of specifications in respect of inventions relating to processes for the preparation or utilisation of raw rubber and latex likely to be of interest to them, and applications were made for English Patents arising out of the work of the staffs in London and the East.

Complete specification accepted during 1940.

529246 Compounding latex.

Complete specifications filed during 1940.

22153/39 Peptising Agents (communicated by the R.R.I., Malaya).

31244/39 Captax as Peptising Agent (communicated by the R.R.I., Malaya).

31245/39 Benzoyl Peroxide as Peptising Agent (communicated by the R.R.I., Malaya).

Other Patents in Force at 31st December, 1940.

428100 Rubber and Road Tar Mixtures.

450222 Hemi-Cellulose Creaming Agent.

415133 Organic Colloidal Addition to Latex.

474651 Concentration of Latex by Creaming.

484712 Rubber and Cement Mixtures.

Patents Abandoned during the year.

465226

476743

476269

476073

(Sgd.) P. J. BURGESS,
Chairman.

(Sgd.) E. CROWHURST,
for Secretary.

Imperial Institute,
July, 1941.

TECHNICAL APPENDIX TO REPORT OF THE LONDON ADVISORY COMMITTEE, 1940.

I.—LATEX.

Object.—The investigations on latex have been concerned chiefly with the elucidation of factors responsible for the technical behaviour of latex so as to devise tests which would be helpful in controlling and improving quality. The problem is complex because of the wide range of non-rubber substances in latex most of which are likely to be of some importance and have different effects according to whether they occur in the rubber particles or in the water or are concentrated at the surface between rubber and water.

Method.—The first step consisted in studying the distribution between rubber and water of certain important groups of substances such as proteins acids and esters. The conclusions regarding proteins were given in the last report, and during this year fatty acids, esters and water-soluble acids have received the most attention. The estimation of these substances by the usual methods proved unreliable necessitating preliminary investigations on the method of determination.

Conclusions.—Improved methods were applied to a study of latex from Ceylon and it was shown that the rubber particles contain not only 0.02 to 0.03 per cent. nitrogen but also esters of long and short chain acids. On keeping the latex for some time these esters are apparently gradually decomposed forming water-soluble ammonium salts and soaps, which then pass out of the rubber, the former into the aqueous serum and the latter mostly into the boundary between rubber and water. Only a small proportion of the protein in latex is at the surface, but this layer is an important factor controlling the properties of preserved latex. It can be easily replaced by soap with corresponding changes in the properties of latex.

Technical Applications.—This picture of the structure of preserved latex is incomplete as the distribution of some groups of substances has not yet been studied, but it is considered to be of considerable technical importance as it is now possible to assess the function of protein, fatty acid and water-soluble acid in the behaviour of latex. The possibility of controlling and perhaps improving quality is enhanced because the factors involved are more clearly defined. The substances at the surface of the rubber particles are of obvious importance in determining stability and coagulation phenomena, but it is known from many experiments that the water-soluble serum substances, most of which are apparently unassociated with the surface of the particles, also play an important part. Their function was at first not clearly understood, particularly when it was demonstrated that surface concentration was not markedly dependent upon concentration in the aqueous phase, but it has now been shown that their action is due to reaction with coagulants and some compounding ingredients thereby modifying considerably the technical behaviour of latex. This is illustrated by a study which has been made of sodium silicofluoride as a coagulant, with the object of devising a suitable gelling test for latex. It was found that the test measured not only the resistance of a given latex to coagulation by electrolytes but also the rate of formation of coagulating ions, a reaction which was found to be retarded considerably by some of the serum constituents. One of the most important compounding ingredients in latex is zinc oxide which, from the Committee's zinc oxide stirring test,

is known to give results parallel to the concentration of water-soluble serum substances. The reaction between zinc oxide and serum cannot be the same as those between sodium silicofluoride and serum, although there may be some points in common such as the mechanical effect of surface-active materials in hindering chemical reactions. The relations between zinc oxide and serum are therefore being studied in detail, and preliminary tests suggest that the water-soluble acids, which it has been shown are wholly in the aqueous phase, are of considerable importance. The extraction of these acids by chemical methods is rather slow and attention is being given to the electro-metric titration of latex which may enable quick comparisons to be made between the aqueous phases of different latices. The technical importance of the surface-active substances at the boundary between rubber particles and water also needs attention, but the investigation is being deferred until sufficient information has been obtained to enable the aqueous or serum phase to be brought under control.

II.—DRY RUBBER.

Fractionation of Caoutchouc.—That rubber contains soluble and insoluble fractions has been known for a long time (Gladstone and Hibbert J.C.S. 1888 p. 680). This fact may prove to be of considerable importance to the plantation industry, since it may be possible to produce on a large scale special types of rubber by selective propagation. Until recently little interest was shown in the subject, but during the past year papers have been published emphasising its importance to the rubber plantation industry. Apart from the possibility of preparing naturally soft rubber, however, the advantages are not as promising as these suggestions imply because nearly all dry rubber is machined (masticated) by manufacturers, both tough and soft rubber being reduced to the same level of plasticity. On the other hand, it is possible that some important differences in rubber hydrocarbons may not be eliminated by mastication and experiments on the fractionation of rubber have been in progress for some time in the Committee's laboratories in so far as staff has been available for the purpose.

Separation of rubber into soluble and insoluble fractions is found to be markedly dependent upon the presence of small quantities of other substances some of which have a purely physical effect which disappears when the substance is removed. In addition the solution of the rubber appears to be a continuous process, the rate following a well-defined law, so that there is no separation into soluble and insoluble fractions but an arbitrary separation of quickly and slowly dissolving rubber. Each fraction probably represents an average and not a clear-cut separation of different hydrocarbons. The rate of solution is slightly retarded by the mechanical arrangement of non-rubber substances and is markedly affected by the period during which the rubber is exposed to a dry atmosphere before immersing in the solvent. The rate of solution of unpurified rubber containing a normal amount of anti-oxygen is unaffected by stirring in the presence of light and air as long as the period of immersion in the solvent does not exceed a few days.

With these conclusions in mind, it is not difficult to devise a simple test for measuring rate of solution, but it is necessary to distinguish between reversible effects due to non-rubber substances and irreversible effects which may represent important differences in the hydrocarbon. It is possible, therefore, that tests comparing different samples of rubber require that solution should be attempted in solvents containing strong polar substances to ensure the elimination of uncontrolled reversible effects due to non-rubber substances. De Vries adopted a similar procedure when comparing the viscosities of solution of different samples of raw rubber.

Variability.—Variability has been the subject of years of research by investigators which, although of incalculable value in defining the factors which affect vulcanising properties, has not definitely been aimed at marketing a special grade of uniform rubber. For this purpose it is necessary to have agreed tests, numerical standards and practical methods of preparation without over-elaborate arrangements for classifying and controlling the product. Detailed schemes of investigations on these lines are in progress both in the East and in London.

Those in London (in the Committee's laboratories) have been concerned chiefly with methods of test, and have shown that testing machines are very reliable as long as they are mechanically sound, but the tensile strength results are markedly dependent upon the sharpness of the knives employed to cut out ring test pieces. Differences in tensile strength of 30 per cent. were found in rings cut from the same slabs by four different laboratories and tested on the same machine. The problem is still under investigation, however, and attention is being given to a bursting test which eliminates errors due to flaws associated with the cutting of the test pieces.

New Types of Rubber and Latex.—Samples of rubber and latex with special properties have been submitted to manufacturers on behalf of the research organisations in the East. Of these softened rubber prepared by treating latex with mercaptobenzthiazole is attracting the most attention.

(Sgd.) G. MARTIN,
Superintendent of Rubber Investigations.

(Sgd.) P. J. BURGESS,
Chairman.

IMPERIAL INSTITUTE,
July, 1941.

Appendix I.

ANNUAL REPORT.

Statistical Section.

A. Design of New Experiments.—See reports of experiments begun by Divisions during this year.

B. Analyses of Data.—Reports on results of experiments, as shown by data submitted, were made to Divisions as follows (for details see Quarterly Reports) :

Soils Division :	35 field experiments
	3 reports on chemical analyses of seedlings, leaves and compost heaps.
Botany Division :	4 field tapping experiments.
	5 reports on physiological (hortomone etc.), manuring, and root experiments.
	3 reports on bark thickness, test tapping and yields of breeding material.
Pathology Division :	1 report on palm oil and bark growth.
Chemistry Division :	4 reports on latex characters (stability, thermal expansion, viscosity and particle size.)
Small Holdings Section :	1 report on growth in experimental plantings on small areas.

C. Sampling Investigations have been carried out with numerous sets of data passing under review, but no reports on this work have yet been written.

D. Experimental Technique.—In co-operation with Mr. Guest much work was done on methods of determining d.r.c. of latex for purposes of yield recording in experiments, and on water content of lumps from latex coagulated in tapping cups. A preliminary report was written, but the work has not yet been completed.

Arising out of this work and that reported in Comm. 244 a suggestion was put forward to prepare instruments of the " metrolac " type with improved and less arbitrary scales, which could be prepared for use in latex diluted with water to a specified degree.

E. One paper has been written for publication, viz.

Viscosity of preserved and concentrated latex III.

F. Fourteen estates were visited during the year (one estate three times). Five of these were visited on an extended tour along the East Coast from Kuantan to Kelantan, where several Small Holdings were also visited.

G. Queries on statistical methods, submitted by research workers in three other organisations, have as usual been welcomed. Time thus used has been about 4 days.

H. A Powers-Four installation was received in October and was put into commission as from 1st November.

H. Fairfield Smith,
Statistician.

Kuala Lumpur,
21st July, 1941.

Appendix II.

Relative Amounts of Research and Advisory Work.

Division.	Average Number of Scientific Staff.			Percentage of time devoted to Research and Experimental Work.			Percentage of time devoted to Advisory Work.		
	1938.	1939.	1940.	1938.	1939.	1940.	1938.	1939.	1940.
Botanical									
All Scientific Officers ..	6 9/12	5 6/12	5 8/12	85	85	**79**	15	15	**21**
Research Officers only ..	4 10/12	3 6/12	3 9/12	78	78	**68**	22	22	**31**
Chemical									
All Scientific Officers ..	5 4/12	4 3/12	3 1/12	74	63	**56**	26	37	**44**
Research Officers only ..	4 4/12	3 5/12	3 3/12	77	66	**58**	23	34	**42**
Pathological									
All Scientific Officers ..	3	2 5/12	3 2/12	64	72	**71**	36	28	**29**
Research Officers only ..	2	1 5/12	2 4/12	47	57	**61**	53	43	**39**
Soils									
All Scientific Officers ..	3 5/12	3 4/12	2 7/12	52	57	**58**	48	43	**43**
Research Officers only ..	2 5/12	2 4/12	2 4/12	35	41	**48**	65	59	**51**
Whole Institute									
All Scientific Officers ..	22 5/12	19 6/12	18 10/12	69	66	**65**	31	34	**35**
Research Officers only ..	17 7/12	14 8/12	16 7/12	63	59	**58**	37	41	**42**

Appendix III.

Lectures given by Institute Staff in 1940.

State or Settlement.	Division.					Total.
	Botanical.	Chemical.	Patho-logical.	Soils.	Experi-ment Station.	
Perak	4		2	3		9
Selangor..	4	1	1	2	2	10
Negri Sembilan .	1		1			2
Pahang	1		1			2
Johore	2					2
Kedah	1					1
Kelantan .. .			2	1		3
Penang & P.W. ..						—
Malacca				1		1
Total ..	13	1	7	7	2	30
Rate per Officer ..	2.3	0.3	2.2	2.4	0.8	1.6

Appendix IV.

Publications in 1940.

Circulars.

No. 11 Drought and Fire Damage : Heat and Sun-Scorch of the Tapping Panel and Seedlings.

„ 12 International Notation for Tapping Systems.

„ 1 (revised Edition, February 1940) Manuring Programme for Replanted and Mature Rubber Trees.

Journal (Vol. 10) Communications.

No. 245	(April)	The Application of Latex to Highway and Floor Surfacing	by W. G. Wren
„ 246	(May)	Amendments and Additions to the International Tapping Notation	by Evan Guest
„ 247	(May)	The International Notation for Tapping Systems (Revised Version ; May 1940)	by Evan Guest
„ 248	(May)	Progress of Breeding Investigations with Hevea Brasiliensis (The Pilmoor Crosses 1928—1931 Series)	by C. C. T. Sharp
„ 249	(June)	Note on the Preservation of Latex by Sterilisation in the presence of a Buffer Solution	by W. S. Davey and F. Beeley
„ 250	(August)	The Concentration of Latex by Centrifugal Machines	by J. H. Piddlesden
„ 251	(October)	Improvement in the Quality of Rubber Planting Material	by C. E. T. Mann
„ 252	(October)	The Use of Serum as a Latex Coagulant	by V. H. Wentworth
„ 253	(December)	Experiments with Economic Tapping Systems (3). Tapping-cum-manuring Experiments on young mature rubber trees : Part I.	by Evan Guest

Planting Manual No. 6.

The Uses and Control of Natural Undergrowth on Rubber Estates. (Second edition—December, 1940).

Planters' Bulletins.

No. 9 28th February, 1940.

„ 10 April, 1940.

„ 11 May, 1940.

„ 12 July, 1940.

„ 13 September, 1940.

„ 14 December, 1940.

Appendix V.

Summary of the Advisory and Administrative Work of the Divisions in 1940, Compared with 1937, 1938, 1939.

	Year.	Division.				Total.
		Botanical.	Chemical.	Pathological.	Soils.	
Visits to Estates (excluding Experiment Station)	1940	215	213	151	200	779
	1939	186	123	80	211	600
	1938	553	99	117	267	1,036
	1937	178	121	83	262	644
Interviews at the Institute	1940	126	195	82	107	510
	1939	114	393	85	110	702
	1938	203	368	124	189	884
	1937	174	349	91	145	759
Letters received ..	1940	2,873	1,290	883	1,233	6,279
	1939	3,166	1,356	1,251	1,604	7,377
	1938	2,558	889	1,444	1,577	6,468
	1937	1,737	927	1,508	1,330	5,502
Letters sent	1940	3,308	1,593	1,188	1,473	7,562
	1939	2,870	931	1,791	1,308	6,837
	1938	3,481	1,425	1,897	1,978	8,781
	1937	1,949	1,162	1,435	1,763	6,309
Specimens and samples received for examination and/or analysis	1940	473	680	275	1,815	3,243
	1939	531	687	399	1,628	3,245
	1938	377	670	529	2,119	3,695
	1937	137	595	764	1,090	2,586
Tours of Visits	1940	8	14	13	23	58
	1939	10	20	5	22	57
	1938	13	21	10	18	62
	1937	11	14	5	23	53
Visits, Interviews and Letters received and sent per working day per Divisional Scientific Officer	1940	3.78	2.80	2.43	3.44	3.20
	1939	3.8	2.2	3.8	3.2	3.2
	1938	3.3	1.1	3.0	2.7	2.2

Appendix VI.

Analysis of Correspondence.

Soils Division.

Subject.	Letters received.	Letters despatched.
Cultivation—		
General Enquiries	3	6
Forestry Methods	3	6
Experiments	41	45
Cover Crops and Natural Covers—		
General Enquiries	45	46
Manuring	8	6
Eradication by Weed Killers	18	17
Manuring	361	424
Soil Conservation and Drainage	10	7
Replanting	175	238
Fertilisers	152	143
Soil Samples	54	58
Experimental Planting under the Rubber Regulation Scheme	266	344
New Planting	13	19
Apparatus	4	6
Leaf—analysis	15	15
Miscellaneous	65	93
Total	1,233	1,473

Botanical Division.

I. Budding		
General, Advice on choice of clones. Clone Records	285	321
Identification of clones on estates	192	255
Field Experiments—Estate Trials	2	2
Growth of Budded Trees	6	5
Purchases and Exchanges of Budwood	33	42
Special materials	1	1
	519	626
II. Tapping		
Estate Enquiries General	69	79
Estate Experiments General	119	145
Estate Enquiries (Tapping of Budded Trees)	38	35
Estate Experiments (Tapping of Budded Trees)	325	188
Test Tapping of Seedlings	2	2
Apparatus and Utensils	2	2
	555	451

Botanical Division—(cont.)

	Letters received.	Letters despatched.
III. Selection		
Individual Mother Trees :		
Selection on estates	20	28
Latex Vessel and Bark Examinations	2	3
Isolation Gardens	12	15
Seed Germination	1	1
Seeds for Experimental Purposes	19	22
Requests for Seeds	1	2
Packing of Seeds	1	2
Identification of Seeds	17	17
	73	90
IV. General Planting Enquiries		
Information on Planting Operation	71	86
Replanting	122	141
New Planting	35	44
Cover Plants	61	76
Thinning	5	7
Pollination	15	23
Non-Hevea rubber producing plants	3	4
Physiology of Latex Production	12	18
	324	399
V. Distribution of R.R.I. 500 Series Clones	671	783
VI. Special Enquiries in connection with Rubber Assessment	6	13
VII. Planting of Experimental Areas on Estates under the Rubber Regulation Scheme	538	590
VIII. Yields of Budded Rubber in Commercial Tapping	118	238
IX. Apparatus	6	8
X. Miscellaneous	63	110
Total	2,873	3,308

Pathological Division.

Root Diseases	183	232
Stem and Branch Diseases	63	69
Leaf Disease (Oidium Heveae)	36	38
Leaf Diseases and Pests (Spider, Hel. etc.)	29	30
Fungicides and Insecticides	60	81
Spraying and Dusting	3	3
Brown Bast	4	4
Lightning Damage	11	13
Replanting	17	24
Cockchafer Grub	102	170
Insects on Rubber Trees	66	84
Insects on Cover Plants	43	48
Diseases of Cover Plants	5	7
Termite Treatment	41	46
Requests for Legume Bacteria Cultures	119	132
Poisoning of Trees in Preparation to replanting	34	57
Miscellaneous	67	150
Total	883	1,188

Chemical Division.

	Letters received.	Letters despatched.
Latex	88	106
Latex Preservation	74	85
Latex Concentration	117	132
Latex—Instruments for determining d.r.c.	52	61
Anti-oxidants of Latex	3	3
Anti-coagulants of Latex	17	17
Coagulation	171	188
Coagulating Tanks and Pans	23	24
Rubber Preparation	118	133
Smoked Sheet	137	155
Crepe	24	26
Water	3	4
Machinery of Rubber Manufacture	21	26
Smoke-houses	193	240
Vulcanisation of Rubber	70	80
Accelerators for Vulcanisation	15	12
New Uses of Rubber	11	12
Softened Rubber	19	26
Patent Specification	28	32
Order for Chemicals	25	30
Apparatus	21	33
Miscellaneous	40	83
Correspondence with Experiment Station	20	85
Total	1,290	1,593

Appendix VII.

Staff Movements in 1940.

Officer.	Appointment.	Assumed duty.	Went on home leave.	Returned to duty.	Left the Service.
C. E. T. Mann	Head of the Botanical Division	—	—	24 February	—
G. Owen	Soils Chemist	—	7 February	9 September	—
E. R. Guost	Botanist	—	18 June	—	11 November
J. H. Piddlesden	Chemical Engineer	—	—	22 March	—
E. D. C. Baptist	Botanist	—	20 March	20 November	—
R. Scott Russell	Botanist	10 May	—	—	—
F. Beeley	Head of the Pathological Division	—	19 April	4 December	—
A. Moore	Personal Assistant to the Director	—	—	23 August	—
A. W. J. Dyck	Soils Chemist	—	—	—	27 December
L. R. Davidson	Advisory Officer, Soils Division	1 December	—	—	—
T. N. Dickson	Manager, Experiment Station	—	—	—	7 Oct. (died)
K. N. Kaimal	Assistant Botanist	—	2 December	—	—
R. H. Moikle	Small-holders' Advisory Officer	—	7 December	—	—
K. S. Pillay	Assistant Soils Chemist	—	4 December	—	—
K. C. Sekar	Assistant Chemist	—	15 May	25 September	—
T. P. S. Sundaram	Assistant Secretary	1 December	—	—	—

Mr. E. E. Pyke arrived on the 15th February, having been sent from London to work at the Rubber Research Institute in co-operation with the staff of the Institute on the physiology of latex formation. The work is financed by a grant by the British Rubber Producers' Research Association in continuation of an earlier arrangement between the Rubber Growers' Association and the Imperial College of Science and Technology, London.

Appendix VIII.

Visitors from Outside Malaya during 1940.

A. d' Angremond, A.V.R.O.S. Proefstation, Medan, Sumatra.

F. D. Ascoli, Dunlop Malayan Estates Ltd., London.

C. Barclay, H.A.P.M., Kisaran, Sumatra.

J. E. Barrs, Newton Chambers & Co., Ltd., Sheffield, England.

A. Beirnaert, I.N.E.A.C., Yangambi, Belgian Congo.

R. B. Bogardas, Goodyear Tire & Rubber Company, Akron, Ohio, U.S.A.

A. P. A. Brito-Mutunayagam, Travancore University, Travancore. S. India.

P. J. S. Cramer, Wassenaar, Holland (c/o Barlow & Co., Singapore).

J. F. H. Cronshey, H.A.P.M., Kisaran, Sumatra.

F. C. Driessen, I.C.H.V.R., Batavia, Java.

W. A. Graham, Charles T. Wilson Co., Inc., New York, U.S.A.

T. R. Harney, Monsanto Chemical Co., St. Louis, U.S.A.

Y. Hasimoto, Ensuico Sugar Manufacturing Co., Ltd., Formosa.

Th. G. E. Hoedt, Proefstation West-Java, Buitenzorg, Java.

A. C. Johan, Sei Poetih Estates, Arnut Factory, Sumatra.

R. Jagat Jyoti, United Press of India, Calcutta.

G. M. Kraay, Department of Rubber Research, Buitenzorg.

E. F. D. Lowe, Liddell Bros. & Co., Ltd., Shanghai.

U. Maung Maung Gyi, K.S.M., Settlement Officer, Rangoon.

R. F. McEntee, Hecht, Lewis & Kahn, New York.

A. A. McPhie, 2/3 Clive Row, Calcutta.

T. E. H. O'Brien, Rubber Research Scheme, Ceylon.

K. Ogawa, Tokyo.

Ong Kee Hin and party of three, Department of Agriculture, Sarawak.

Ch. Press, Nitrate Corporation of Chile Ltd., New York.

H. Ramiah, United Press of India, Calcutta.

W. J. C. Richards, Fairweather, Richards & Co., Ltd., Rangoon.

H. J. Spencer, Kuching, Sarawak.

K. Tani, Poeloe Mandi Estate, Sumatra.

Udom Udompol, Bangkok, Thailand.

H. Vonk Wilhelmnalaan 46, Batavia-Centrum Java.

Appendix IX.

Meteorological Observations, 1940.

At the Rubber Research Institute of Malaya, 3rd Mile, Ampang Road, Kuala Lumpur.

Month.	Temperature °F.		Mean Relative (%) Humidity at 9.00 a.m.	Rainfall inches.	No. of rainy days.	Bright sunshine daily means (hours).	Atmospheric pressure Millibars (m.s.l.) 9.00 a.m.
	Mean Maximum.	Mean Minimum.					
January ..	90.5	71.5	76	4.52	12	6.5	1013.1
February ..	91.8	71.4	76	7.93	14	7.0	1014.6
March ..	94.0	72.8	79	10.84	18	6.4	1012.8
April ..	92.4	74.0	84	8.57	21	6.3	1013.2
May ..	91.6	74.6	84	9.70	15	5.8	1011.5
June ..	91.0	73.6	85	5.20	12	5.6	1011.9
July ..	91.5	72.4	83	2.14	5	6.5	1012.9
August ..	89.7	72.4	83	6.05	15	5.3	1012.6
September ..	89.1	72.3	83	8.25	18	4.3	1013.8
October ..	90.9	72.5	83	9.26	19	5.2	1014.3
November ..	88.9	72.6	84	10.74	25	4.6	1012.5
December ..	89.5	72.3	82	5.68	14	5.5	1014.2
Annual ..	90.9	71.3	82	88.9	188	5.8	
		Means.		Totals.		Mean.	

Rainfall at the R.R.I. Experiment Station, Sungei Buloh.

Month.	Rainfall inches.	No. of rainy days.	Average for 10 years 1931/1940.	Difference from average for 10 years (+ or −).
January ..	8.29	10	8.13	+ .16
February ..	2.66	8	5.89	− 3.23
March ..	5.64	9	9.93	− 4.29
April ..	7.72	17	10.61	− 2.89
May ..	10.18	18	7.54	+ 2.64
June ..	3.08	8	4.02	− .94
July ..	3.18	6	3.45	− .27
August ..	8.56	15	6.76	+ 1.80
September ..	6.74	16	7.12	− .38
October ..	9.65	16	10.89	− 1.24
November ..	13.11	20	10.95	+ 2.16
December ..	16.32	13	10.57	+ 5.75
Total ..	95.13	156	95.86	− .73

ANNUAL REPORT.

SOILS DIVISION.

Index.

	Page.
Advisory work	37
Cover plants and soil management	36
Laboratory work	37
Manuring:	
Immature trees	36
Mature trees	35
Pot-culture work	37
Soil survey work	35
Staff	35

ANNUAL REPORT.

BOTANICAL DIVISION.

Index.

	Page.
Advisory work	85
Bark renewal :	
Density of planting, effect on	46
Stimulation by Palm oil	77
Breeding investigations	64
Budwood, distribution of	65
Bud-grafted trees :	
Direction of tapping, effect on yield	62
Growth and yields	41
Height of tapping and yields	62
Summary of yields at R.R.I. Experiment Station	42
Tapping experiments on R.R.I. Experiment Station	49
Tapping experiments on various estates	51
Catch-crop experiment	84
Clonal seeds :	
As stocks for budding	39
Trials	66
Clones from 1938 crosses	66
Clones, identification on estates	86
Density of planting experiment	46
Ecological Studies :	
Experiments on R.R.I. Experiment Station	79-82
Field experiments on estates	82
Catch-crop experiment	84
Clone trial on peat land	84
Methods of planting	84
Pests and diseases	85
Stock experiments	83
Field experiment on R.R.I. Experiment Station, new	82
Girth rate and yield correlation	59
Growth-promoting substances :	
Treatment of budded-stumps	38
Treatment of cover plant seeds	78
Treatment of Heavea Seeds	78
Manuring :	
Effect on tapping systems	59
Pests and diseases	85
Physiological investigations	76
Bark renewal, stimulation	77
Nutrition pot-culture experiments	76
Seeds, treatment of with growth substances	78
Planting :	
Densities	46
Methods of	84
Planting material	83

BOTANICAL DIVISION—(*cont.*).

Index.

	Page.
Pollination by hand	64
Large-scale	65
Results of 1940	68
Yields from 1928-1931 series	65
Pot-culture experiments	76
Propagation, vegetative	38
Root pruning of budded stumps	38
Seedlings from isolated seed gardens	66
Seedling trees, comparison of tapping systems on	48
Selection and breeding	64
Clone collection	64
Clones from 1938 crosses	66
Hand pollination	64
New clones from estate mother-trees	64
New clones from illegitimate seedings of high-yielding clones	66
Staff	38
Stock-scion relationship in buddings:	
Clonal seedlings as stocks for buddings	39
Influence of scion on yield of stock	41
"Twin" plant experiments	39
Tapping investigations	46
Budded trees, "large scale" experiments on	50
Budded trees, "single task" experiments on	55
Direction of tapping, effect on yield of budded trees	62
Height of tapping, influence on yield of budded trees	62
Miscellaneous tapping experiments	61
New, undertaken during the year	63
Seedling trees, experiments on	48
"Slaughter" tapping	62
Tapping systems, experiments on R.R.I. Experiment Station	49
Tapping systems and manuring	59
Vegetative propagation	38
Weather conditions	82
Yields:	
And tapping costs	48
Clones from estate mother-trees	64
Clones from legitimate seedlings (R.R.I. 500 series)	65
Early indications of	75
From 1928-1931 series of hand pollinated seedlings	65
Illegitimate seedlings of high-yielding clones	66
Record of budded trees at R.R.I. Experiment Station	41
Tjikadoe Isolated Seed Garden Seedlings	66

ANNUAL REPORT.

PATHOLOGICAL DIVISION.

Index.

	Page.
Advisory work, summary	114
Bacteriology	112
Bagworms	110
Bark-bursts	102
Black stripe	101
Brown Bast	101
Buddings, diseases of	102
Carbon bisulphide	106
Carbon tetrachloride	106
Catantops humulis	109
Catantops splendens	109
Caterpillars	110
Clania variegata snell	110
Cockchafers	104
Coptotermes	106
Cutworms	110
Diseases, above ground	101
Eelworms	111
Epilachna indica Muls.	109
Exopholis	105
Fungicides, testing of	101
Giant snail	111
Grasshoppers	109
" Ialine " ordinary disinfectant	101
Insect pests of rubber trees and cover plants	109
Lachnosterna	105
" Lady-bird " beetle	109
Latex bacteriology	113
Leaf diseases	103
Lepidiota	104
Leucopholis	104
Mercury perchloride	107
Methallyl chloride	106
Mexican bean beetle	109
Minor leaf diseases	103
Mouldy rot	101
Oidium heveae	103
Paradichlorbenzine	106
Paragerm	101
Patch canker	101
Pests	109
Phytophthora diseases	101
Pink disease	102

PATHOLOGICAL DIVISION—(*cont.*).

Index.	Page.
Potassium sulphocarbonate	106
Psilopholis	104
Publications	115
"Pyralid caterpillars"	111
Rhizobia cultures	112
Rodent damage	107
Root-disease investigations	89
Sodium chlorate versus sodium arsenite	98
Squirrels	107
Staff	89
Stem diseases	102
Sunscorch of the tapping panel	101
Tapping panel diseases	101
Termites	106
Valanga nigricornis	109
White ants	106

ANNUAL REPORT.

CHEMICAL DIVISION.

Index.

	Page.
Advisory work	131
Age resistance	123
Aluminium equipment	129
Bacteria in latex	117,119,120
Bale packing	130
Carracrol as a latex preservative	119
Caoutchol	118,126
Centrifugal machines for latex concentration	121
Coagulants	127
Cominal G.A.R. as a latex preservative	119
Concentrated latex, demand for	116
Creaming of latex	122
Crepe, acid value of	117
Crude Rubber Committee of American Chemical Society	122
Dibromo-quinono-chloramide as a latex preservative	119
Dirt in rubber	130
Discolouration of latex	119
D.P.G. mix for testing age resistance	123
Drum linings for latex shipment	119
Estate supplies	127
Estate technique	130
Gauze strainers	129
Guaiacol as a latex preservative	119
Latex—	
Acetone extract of dried film	117
Acid value of dried film	117
Bacterial activity in	117,119,120
British Standard Tests for	118
Changes in acid value	117
Chemical Constitution	117
Chemistry and Technology	117
Concentrates demand for	116
Concentration in Centrifugal Machines	121
Concentration by creaming	121
Containers for	119
Discolouration	119
Preservation	119
Sterilization by autoclaving	120
Testing, training of estate staff	118
Lectures	132
Methyl cellulose as creaming agent	122
Modified rubber	126
Modulus	124
Packing of rubber	129,130

CHEMICAL DIVISION—(*cont.*).

Index.	Page.
Papain	126
Parachlormetacresol as a latex preservative	119
Paranitrophenol	129
P.B. 186—soft rubber	126
Peptising Agents	127
Plasticity	126
Publications	132
Rate of cure	124
R.R.I. analysis of latex samples	118
Rubber from skim latex	121
Sampling of crude rubber	123
Santobrite—health hazards in use	120
Scrap drying shed	130
Serum, use of in coagulation	128
Skim latex crepe	121
Smoke houses	130
Sodium phenyl phosphate as a latex preservative	119
penta chlorphenate	119
salt of benzylated chlorphenol	119
sulphite	130
Softened rubber	127
Staff	116
Standardization of testing	118, 127
Sulphuric acid	127, 128
Tapping systems—effect on variability	126
Technological studies of rubber	122
Testing	118
Tetra potassium pyrophosphate as a preservative for latex	119
Titanium oxide for filming latex containers	119
Toddy as a source of coagulant	128
Tunnel smoke houses	130
Urea as a latex preservative	120
Variability in raw rubber	125
Water absorption	126
Wax as lining for latex containers	119

ANNUAL REPORT.

EXPERIMENT STATION.

Index.

	Page.
Acreage	133
Baling	141
Buildings	142
Budwood, distribution	137
Chemical Division experiments	140
Clearings	135
Clonal seed, distribution	137
Hand pollination	137
Immature areas	135
Labour, health	143
Lectures	144
Manurial trials	137
New clearings	133
Nurseries :	
Main multiplication	134
Hand-pollination	134
Clonal seed	135
Pathology Division areas	139
Rainfall	143
Refresher courses for conductors	143
Root diseases, inspections	139
Routine field work	141
Rubber crop, revenue	142
Soils Division areas	137
Staff	144
Tapping experiments	136
Visitors	144

ANNUAL REPORT.

SMALL-HOLDERS' ADVISORY SERVICE.

Index.

	Page.
Acknowledgments	154
Advisory Committee	148
Advisory Policy	148
Agricultural shows	154
Ampang demonstration plots	154
Bark survey on small-holdings	154
Catch-crops	151
Co-operative Societies Department	149
Instructors: (A.R.Is.)	
At the Experiment Station	147
Appointments	145
Distribution	146
M.A.H.A. Show	154
New planting	150
Pests and diseases	150
Propaganda and Marketing Committee	148
Preparation and marketing of rubber	148
Planting material	153
Replanting	151
Rural Lecture Caravan	154
Staff	145
Superintendent Instructors	147
Smoke-houses	149
Tapping	150

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Edited by C. E. T. Mann on behalf of the Board of the Rubber Research Institute of Malaya.